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TOXIC CHEMICAL SURVEY OF MUNICIPAL DRINKING WATER SOURCES IN THE ATLANTIC REGION (1985 - 1988): EVALUATION OF QUALITY CONTROL DATA FOR ORGANIC PARAMETERS

IWD-AR-WQB-90-167

INLAND WATERS DIRECTORATE
ATLANTIC REGION
WATER QUALITY BRANCH
MONCTON, NEW BRUNSWICK

Canada

91-04414/

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Daniel A. Léger

Environment Canada
Conservation and Protection
Inland Waters Directorate
Water Quality Branch
P.O. Box 861
Moncton, N.B.
E1C 8N6

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Executive Summary

Laboratory data is only as good as you can prove it to be. That's why agencies involved in producing and interpreting such data have been placing increasing emphasis on quality control (QC) and quality assurance (QA) protocols in recent years.

The recent "Atlantic Region Federal-Provincial Toxic Chemical Survey of Municipal Drinking Water Sources", conducted between 1985 and 1988, was supported by extensive QC measures. In fact, approximately 25% of analytical resources were spent on QC.

This report provides an evaluation of the QC data that was produced for organic toxic chemicals during the survey.

The samples were analyzed for the following groups of chemicals: organochlorines (OCs), chlorobenzenes (CBs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organophosphorous pesticides (OPs), chlorinated phenols (CPs) and carbamates. The data were examined by year, province and by water types. Trends were assessed and problem areas discussed.

Basically, the QC protocol consisted of adding known amounts of toxic chemicals to some water samples at the time of sampling. The amounts reported by the laboratory then gave an indication of the quality of the overall sampling and analysis protocol. Consistent recoveries of 100% indicated excellent performance.

It was found that some groups, like CPs, performed better than others such as carbamates. Also, some compounds performed much better than others within the same group, as was the case with the PAH fluoranthene. Generally, the quality of the data improved in the later years of the study. This is consistent with improvements in technology, instrumentation and methodology that took place over the years and also reflects the growing emphasis put on QA/QC.

The success of an analysis is thus mostly dependant upon the nature of the compound to be analyzed, since it dictates the lab's capability to preserve the compound intact until analysis, extract it from the water sample, remove impurities by various clean-up procedures and then measure it's quantity.

Abstract

This report provides an evaluation of the quality control (QC) data that were produced for organic toxic chemicals during the "Atlantic Region Federal-Provincial Toxic Chemical Survey of Municipal Drinking Water Sources (1985-1988)". The data were examined by year, province, and by water types (distilled vs ground vs surface). Trends were assessed and problem areas were discussed.

The samples were analyzed for the following groups of chemicals: organochlorines (OCs), chlorobenzenes (CBs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organophosphorous pesticides (OPs), chlorinated phenols (CPs), and carbamates.

It was found that OCs analysis was improved over the years to the point where results in later years were considered quite reliable.

In the case of CBs, the QC results showed that recoveries of lower substituted CBs were biased low, probably because of their higher volatility. This means that results, if any, reported for those CBs in real samples, probably represented low estimates of the real amounts.

PCBs were only analyzed in 1985, but available QC data showed good performance was achieved for that analysis.

PAHs showed variable recoveries during the study. Some like fluoranthene, the only PAH spiked in all years, showed good overall recoveries, so that results for this compound can be considered reliable. Others like B(k)Fl or indeno perylene seemed to have presented difficulties and stopped being analyzed at some point during the study. Results for those PAHs should be viewed with caution.

OPs were among the worst performers in the study. Results for OPs should thus be viewed with caution.

Overall recoveries of CPs were very good in all years of the study and no problem compounds were noted. Results for CPs can therefore be considered reliable.

The QC data clearly showed that carbamates were problematic. Problems with laboratory instrumentation resulted in no carbamates being analyzed in 1987 and only carbaryl being analyzed in 1985 and part of 1986. Carbamates results should therefore be viewed with caution.

Sommaire

Ce rapport présente une analyse des données du contrôle de la qualité (CQ) produites pour les substances organiques toxiques lors de l' "Étude Fédérale-Provinciale des Substances Chimiques Toxiques Présentes dans les Sources Municipales d'Eau Potable de la Région de l'Atlantique (1985-1988)". Les données ont été examinées selon les années, les provinces et le type d'eau (distillée vs souterraine vs surface). Une discussion est présentée sur les tendances et les problèmes rencontrés.

Les échantillons ont été analysés pour les groupes chimiques suivant: organochlorés (OC), chlorobenzènes (CB), hydrocarbures aromatiques polycycliques (HAP), biphényles polychlorés (BPC), pesticides organophosphorés (OP), chlorophénols (CP), et carbamates.

Il a été trouvé que l'analyse des OC s'est améliorée au cours des années jusqu'au point où les résultats produits lors des dernières années de l'étude ont été considérés comme étant fiables.

Les résultats du CQ ont montré que les recouvrements des CB moins substitués étaient régulièrement plus bas, dû probablement à leur volatilité plus élevée. Cela signifie que les résultats positifs rapportés pour ces CB dans les vrais échantillons, s'il y en avaient, représentaient probablement une sous-estimation des vraies quantités présentes.

Les BPC ont été analysés en 1985 seulement et les données disponibles démontrent une bonne performance pour cette analyse.

Les recouvrements des HAP ont varié lors de l'étude. Certains comme le fluoranthène ont démontré d'excellents recouvrements, alors que d'autres comme le B(k)Fl ou l'indino pérylène ont présenté des difficultés et n'ont plus été analysés après un certain temps. Les résultats pour ces derniers devraient donc être utilisés avec prudence.

Les OP ont présenté en général les pires recouvrements de l'étude. Les résultats devraient donc être utilisés avec prudence.

Le recouvrement des CP a été très bon durant toutes les années du projet et aucun CP n'a présenté de difficultés. Les résultats peuvent donc être considérés comme étant fiables.

Les données du contrôle de la qualité ont clairement démontré que les carbamates étaient problématiques. Des problèmes avec les instruments de laboratoire ont fait que les carbamates n'ont pas été analysés en 1987 et que seulement le carbaryl a été analysé en 1985 et en partie en 1986. Les résultats pour les carbamates devraient donc être utilisés avec prudence.

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1. Introduction

Between 1985 and 1988, the Water Quality Branch, Atlantic Region, conducted an extensive survey to determine the quality of raw water sources used by municipalities throughout Atlantic Canada (Environment Canada, 1989). Approximately 150 different municipal raw water sources were sampled during this survey, and over 100,000 parameter results were generated, many of them from quality control (QC) samples.

This report summarizes the QC data that was generated for organic toxic chemicals.

The QC data for organic parameters associated with this four year survey was based on spikes and distilled water blanks that were processed along with the samples. The spikes were made of either distilled water or natural water to which was added 100 uL of a standard solution in methanol. This solution contained known concentrations of selected organochlorines (OCs), chlorobenzenes (CBs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and organophosphorus pesticides (OPs), chlorinated phenols (CPs) or carbamates.

Those spikes provided information multidimensional in nature since the study covered four years, four provinces, different water types, and seven groups of organic chemicals. The QC data were thus examined by chemical groups with the following questions in mind:

(1) Were there differences in the QC data over the years as there had been changes in methodology, procedures, and technology?

(2) Were there differences between provinces as there had been variations in transport time, field personnel and type of natural water?

(3) Were there differences between distilled water spikes and natural water spikes?

Also, no attempts were made to pinpoint the source of anomalous QC results, unless the cause was documented at the time of occurrence. Such an attempt would have been futile given the staggering number of possible causes and effects created by variations in the overall analytical process over the years (changes in methodology, field and lab personnel, instrumentation, etc) and by the large number of manipulations that took place on each sample. At best, one could only suggest factors or events that could have influenced the QC data into being what it is.

This point can be illustrated by considering a typical natural water spike processed for organochlorines. Such a spike was subjected to about 15 physical and 7 chemical manipulations, all prone to errors, before yielding raw data (e.g. chromatograms) which was also subjected to various manipulations before being reported. Furthermore, each and every one of those manipulations was subjected to a myriad of external factors that could have influenced the quality of the data.

As an example, let's consider the simple step of spiking a natural water sample, only one of the seven chemical manipulations involved. Typically, it consisted of adding precisely 100 uL of the standard solution directly into the sample. This solution contained known amounts of selected pesticides and pollutants. Many factors could have affected this step and ultimately caused errors in the data. An incorrectly prepared spiking solution that didn't match the quantitation standard used in the lab could obviously have caused consistently low or high recoveries for individual parameters in a given spiking period. Also, freshly prepared spiking solutions that didn't match solutions used in previous sampling trips could have caused variations in apparent recoveries over the years. The temperature of the solution at the time of spiking could have caused errors of about 1%/10 °C below room temperature because of changes in it's density, but the benefits of keeping the spiking solution cold to prevent degradation and evaporation greatly outweigh this factor. Evaporation of the solvent from the spiking solution could have caused abnormally high recoveries throughout the chemical groups. This problem is accentuated when small volumes of the solution are kept in a large vial. Degradation of unstable organic compounds, like carbamates, in the spiking solution could have resulted in apparent low recoveries. Different syringes used by different field personnel could have caused variations in recoveries between provinces and sampling trips due to variations in the volumes delivered. Also, the way each individual handled the syringe, the spiking solution and the sample could have caused abnormal QC results through losses, errors, degradation or contamination.

Some external factors could also have influenced QC results in a way that is more difficult to assess. To name a few, pH, temperature, oxygen content and organic content could have affected the stability of some compounds, reducing it for some, enhancing it for others. The presence of native pollutants and pesticides in the sample could have caused abnormally high recoveries since in this case there would have been no way to distinguish between native and spiked compounds. Also, some spiked compounds could have been metabolized by microorganisms in the water, causing lower apparent recoveries, but their activity depends on many parameters such as pH, temperature, oxygen, nutrients, etc.

As can be seen, many factors could have affected the simple step of spiking a water sample. But a great many more come in effect when the 21 other steps the samples go through are considered.

The QC data presented in this report were therefore examined in an overall manner, and individual anomalous results should be regarded as a warning that errors are always possible and that strict control is required at all steps of the analytical process (sampling, spiking, analysis, interpretation, data processing, etc).

A table listing all QC samples and their recoveries for the period 1985-88 can be found in appendix A, while yearly statistics can be found in appendix B. Provincial statistics can be found in appendix C, but 1985 recoveries were not included since Prince Edward Island only became part of the study in 1986. Also, a comparison of distilled water versus ground water and surface water spikes can be found in appendix D. Only 1987-88 recoveries were included because distilled water spikes were consistently done in those years.

In order to be able to present a global picture of the QC data, spikes recoveries were further summarized as chemical groups. The resulting global statistical summaries can be found in tables 1 to 4 and were also graphically represented in figures 1 to 19.

For various reasons, some parameters stopped being analyzed or spiked at some point during the study. Examples are pp-DDD, endrin and dieldrin, which were not analyzed after 1985. Also, some samples showed no data for some chemical groups or individual parameters, either because of interferences or because they were lost during laboratory workup. Examples are samples 601100 and 703139 which showed no recoveries for OCs. Such samples were not taken into account in statistical calculations.

It should be noted that three spiking solutions were used to spike each set of pesticides QC samples (four bottles). One solution contained OCs, PCBs, PAHs, CBs, OPs and triazine herbicides and was used for the 1 L CB spikes and the 4 L OC, PCB, PAH and OP (combined) spikes. A second solution contained chlorinated phenols, dinoseb and MCPA and was used for the 1 L CP spikes. A third solution contained carbamates and was used for the 1 L carbamate spikes.

It should also be noted that the 1 L CB spikes and the 4 L OC, PCB, PAH and OP (combined) spikes were preserved in the field with hexane. The 1 L carbamate spikes were preserved (pH 3) in the field with hydrochloric acid in 1985 only, while the 1 L CP spikes were not preserved.

Finally, for the purpose of discussing the QC data, recoveries outside 40% to 155% were arbitrarily considered "abnormal". This range is what can be normally expected from trace organic chemical analysis.

2. Results and Discussion

2.1 Organochlorines (OCs)

During the period 1985-88, 859 QC tests for OCs were generated for 77 samples. Six samples showed no data and 50 abnormal values were noted. The overall average mean recovery for OCs was 94.0% with an average standard deviation of 29.8 (table 1 & fig. 1). Recoveries ranged from 27% to 242% and mean recoveries from 75% to 144%.

On a yearly basis (table 2 and fig. 2), in 1985, the average mean was 109.6% with an average standard deviation of 38.4. Recoveries ranged from 28% to 242% and mean recoveries from 77% to 169%. Twenty six high recoveries (over 155%) and 3 low values (below 40%) were noted out of 170 tests. Aldrin, pp-DDD, heptachlor epoxide, endrin and dieldrin stopped being spiked after 1985. In 1986, the average mean was 72.3% with an average standard deviation of 18.2. Recoveries ranged from 27% to 228% and mean recoveries from 42% to 104%. Four high values and 7 low values were noted out of 216 tests. The compound o,p-DDT stopped being spiked after 1986. In 1987, the average mean was 74.8% with an average standard deviation of 15.7.

Recoveries ranged from 29% to 141% and mean recoveries from 56% to 105%. No high values and 10 low values were noted out of 209 tests. In 1988, the average mean was 98.6% with an average standard deviation of 13.9. Recoveries ranged from 43% to 158% and mean recoveries from 88% to 114%. One high value and no low values were noted out of 264 tests.

Overall recoveries of OCs were thus excellent although the overall standard deviation was high. The very high standard deviations obtained in 1985 significantly contributed to this high number. The overall standard deviation fell to 15.9 when recalculated without the 1985 data.

The number of high values and the data in general for 1985 indicate there may have been a problem with the spiking solution, the spiking itself or the laboratory quantitation standard. But the randomness of these high values and the relatively high average standard deviation for OCs in that year indicate the problem may also have been with the chromatography/quantitation process. Aldrin, a-chlordane and pp-DDE seemed to have been problematic in that regard. For example, samples 500670 to 500850, collected in the 1985 Spring sampling trip, showed high recoveries (150-220%) for pp-DDT, pp-DDE, heptachlor, heptachlor epoxide and dieldrin, leading one to believe those samples may have been spiked twice. But other OCs in the same spiked samples, like methoxychlor, a-endosulfan, g-BHC and mirex, showed relatively normal recoveries (91-130%), indicating certain OCs may have been present in too high a concentration in the spiking solution used at that time. It is also possible the concentration of those OCs in the laboratory quantitation standard may have been too low. Spikes 501757 to 502173, prepared from a new spiking solution during the 1985 Fall sampling, showed similar trends although less prominent. Those spikes showed consistently high recoveries for a-chlordane indicating a problem with this particular compound in the spiking or laboratory standard, while varied recoveries (64-240%) of pp-DDE indicated a possible problem with interferences in the chromatography/quantitation process. Low values could also have been caused by errors in spiking or by the spiking and quantitation standards, but were most likely caused by losses inherent to the analytical workup. The QC data in subsequent years showed a significant reduction in the number of abnormal recoveries for OCs, so no further speculation will be made on their sources.

The 1986 recoveries showed a substantial improvement over those of 1985, as shown by the lower average mean, the improved average standard deviation, narrower range of mean recoveries and drastic reduction in the number of high values. It can be noted that spikes 600968 and 600969 showed very high recoveries of pp-DDT and pp-methoxychlor, but recoveries of these two compounds from other spikes were normal. The 1987 QC data were considered as good or slightly better than 1986 with a higher average mean and lower average standard deviation. Range of recoveries and mean recoveries were also narrower. Although 10 low values were noted, 4 were at 39%, very near the 40% limit. No problem compounds were noted in 1987. Data for 1988 showed excellent recoveries and standard deviations and no problem compounds were noted.

Figure 2 clearly shows the significant improvement in OC QC results that took place over the years, with 1988 yielding the best QC data. This is consistent with improvements in technology, instrumentation and methodology that took place over the years and also reflects the growing

emphasis put on QA/QC in recent years. Since most high recoveries values (30 out of 31) can be found in 1985 and early 1986, positive values reported for OCs in those years should be viewed with caution.

Province wise (fig. 3), for New Brunswick, the average mean for OCs was 98.5% with an average standard deviation of 22.1. Recoveries ranged from 29% to 228% and mean recoveries from 70 to 124%. Four high values and 2 low values were noted out of 204 tests. For Nova Scotia, the average mean was 80.5% with an average standard deviation of 22.4. Recoveries ranged from 29% to 158% and mean recoveries from 67% to 102%. One high value and 7 low values were noted out of 169 tests. For Prince Edward Island, the average mean was 79.0% with an average standard deviation of 18.8. Recoveries ranged from 27% to 144% and mean recoveries from 65% to 98%. No high values and 5 low values were noted among 147 tests. For Newfoundland, the average mean was 80.0% with an average standard deviation of 18.4. Recoveries ranged from 34% to 130% and mean recoveries from 72% to 101%. No high values and 3 low values were noted among 169 tests.

Every province thus showed good OC recoveries. The recoveries for New Brunswick were higher than those of other provinces, but New Brunswick showed many high values and what seemed to be a high bias. The spiking technique and the syringe used in New Brunswick may have been the cause. Nova Scotia, Prince Edward Island and Newfoundland showed recoveries similar to one another, but Prince Edward Island and Newfoundland QC data were considered slightly better than New Brunswick and Nova Scotia, showing better standard deviations, narrower range of recoveries and less abnormal values. It has been suggested this may be because one person only in each province of Newfoundland and Prince Edward did the spiking while two or more persons did the spiking in New Brunswick and Nova Scotia. Nonetheless, continued efforts should be made to reduce variations in spiking.

The distilled water QC spikes for OCs gave an average mean of 85.6% with an average standard deviation of 19.1 (fig. 4). Recoveries ranged from 32% to 153% and mean recoveries ranged from 71% to 109%. No high values and 5 low values were noted among 176 tests. The ground water spikes gave an average mean of 93.6% with an average standard deviation of 17.5. Recoveries ranged from 29% to 150% and mean recoveries ranged from 83% to 118%. No high values and 2 low values were noted among 143 tests. The surface water spikes gave an average mean of 85.9% with an average standard deviation of 19.6. Recoveries ranged from 37% to 158% and mean recoveries ranged from 71% to 103%. No high values and 2 low values were noted among 154 tests.

Good OC recoveries were thus obtained from all three water types, but ground water spikes showed better recoveries and slightly narrower standard deviation than distilled and surface water spikes, which showed similar QC data. There are no clear explanations for this at the moment.

2.2 Chlorobenzenes (CBs)

During the period 1985-88, 270 QC tests for CBs were performed on 77 samples. Five samples showed no data and 15 abnormal values, all low, were noted. The average mean was 72.2% with an average standard deviation of 19.8 (fig. 1). Recoveries ranged from 4% to 143% and mean recoveries from 55% to 91%.

It can be noted (appendix A) that lower substituted chlorobenzenes like 1,3-DCB showed lower recoveries than higher substituted CBs like HCB. This is consistent with the fact that lower substituted CBs are more volatile and probably suffered more losses from the evaporation/ concentration steps during analytical workup. Losses by evaporation may also have occurred during transport and storage of the spiked samples.

On a yearly basis (table 2 and fig. 5), in 1985, the average mean for CBs was 54.6% with an average standard deviation of 12.1. Recoveries ranged from 31% to 105% and mean recoveries from 46% to 65%. No high values and 2 low values were noted out of 30 tests. In 1986, the average mean was 67.0% with an average standard deviation of 18.1. Recoveries ranged from 20% to 115% and mean recoveries from 50% to 77%. No high values and 4 low values were noted out of 56 tests. Three samples showed no results. In 1987, the average mean was 65.8% with an average standard deviation of 18.3. Recoveries ranged from 4% to 143% and mean recoveries from 48% to 91%. No high values and 7 low values were noted out of 92 tests. One sample showed no results. In 1988, the average mean was 84.7% with an average standard deviation of 15.6. Recoveries ranged from 31% to 122% and mean recoveries from 68% to 96%. No high value and 2 low values were noted out of 92 tests. One sample showed no results.

There was thus a general improvement in CB recoveries from 1985 to 1986, although 1985 showed the best standard deviations of all years for 1,3-DCB and 1,3,5-TCB. The year 1987 yielded good QC data similar to 1986, while 1988 showed excellent recoveries with good standard deviations. This is again consistent with improvements in technology and a stronger emphasis put on QC in recent years.

Province wise (fig. 6), QC data for CBs for New Brunswick showed an average mean of 76.6% with an average standard deviation of 16.5. Recoveries ranged from 40% to 122% and mean recoveries from 59% to 98%. No high or low values were noted out of 68 tests. For Nova Scotia, the average mean was 78.6% with an average standard deviation of 19.8. Recoveries ranged from 37% to 143% and mean recoveries from 58% to 102%. No high value and 3 low values were noted out of 59 tests. One sample showed no results. For Prince Edward Island, the average mean was 69.2% with an average standard deviation of 15.9. Recoveries ranged from 31% to 115% and mean recoveries from 54% to 82%. No high values and 2 low values were noted among 46 tests. Four samples showed no results. For Newfoundland, the average mean was 69.1% with an average standard deviation of 23.5. Recoveries ranged from 4% to 121% and mean recoveries from 51% to 82%. No high values and 8 low values were noted among 67 tests.

All provinces thus showed good CB recoveries. New Brunswick and Nova Scotia showed the best recoveries, while Prince Edward Island gave similar recoveries but better standard deviations than Newfoundland which showed the highest deviations. This observation and the number of low values for Newfoundland indicated transport time may have had a detrimental effect on the recoveries of the more volatile CBs.

The distilled water QC spikes for CBs gave an average mean of 73.8% with an average standard deviation of 18.0 (fig. 7). Recoveries ranged from 27% to 133% while mean recoveries ranged from 55% to 94%. No high values and 4 low values were noted among 76 tests. The ground water spikes gave an average mean of 74.5% with an average standard deviation of 20.3. Recoveries ranged from 31% to 122% while mean recoveries ranged from 59% to 90%. No high values and 2 low values were noted among 48 tests. The surface water spikes gave an average mean of 77.7% with an average standard deviation of 22.6. Recoveries ranged from 4% to 143% while mean recoveries ranged from 60% to 97%. No high values and 3 low values were noted among 60 tests.

The three water types thus showed similar CB recoveries, but distilled water showed slightly better standard deviation than ground water and surface water spikes. Distilled water usually contains less interfering compounds and shows a cleaner "front end" on chromatograms, where CBs are found, thus favouring more consistent data. Surface water on the other hand usually contains more interfering material and this is reflected by the slightly higher recoveries and higher standard deviations obtained from surface water spikes. Nonetheless, the effects of water type on CB recoveries from hexane preserved samples were considered minimal.

2.3 Polychlorinated Byphenyls (PCBs)

PCB spikes were done only in 1985. None were done in the following years. Consequently, a discussion by year, province or water type is either not possible or impractical.

In 1985, 10 tests for PCBs were performed on 10 QC samples. No abnormal values were noted. Mean was 75% with a standard deviation of 8. Recoveries ranged from 65% to 90%. Based on this limited number of spikes, good performance was obtained for PCB analysis.

2.4 Polynuclear Aromatic Hydrocarbons (PAHs)

During the period 1985-88, 281 QC tests for PAHs were performed on 77 samples. Five samples showed no data and 34 abnormal values were noted. Average mean was 82.4% with an average standard deviation of 28.1 (fig. 1). Recoveries ranged from 6% to 165% and mean recoveries from 55% to 100%.

It should be noted that indeno pyrene stopped being spiked after 1985 due to difficulties with the analysis. Also, all PAHs except fluoranthene stopped being spiked after 1987.

The difficulties in analyzing PAHs are reflected by the high number of abnormal values (mostly low values) and by higher standard deviations. Benzo (k) fluoranthene seemed to have been especially problematic as it accounted for most low values and showed low mean recovery and high standard deviation. PAHs are generally considered to be less stable than chlorinated compounds and low recoveries probably resulted from degradation in the spiked samples or by losses during the cleanup steps. The few high values were most likely caused by interfering compounds present in the natural water used for the spikes. Fluoranthene, the only PAH found in some real samples, afforded good overall recoveries with a mean of 100% and a standard deviation of 30.

On a yearly basis (table 2 and fig. 8), in 1985, the average mean for PAHs was 92.5% with an average standard deviation of 26.2. Recoveries ranged from 35% to 136% and mean recoveries from 73% to 110%. No high values and 2 low values were noted out of 60 tests. In 1986, the average mean was 88.5% with an average standard deviation of 26.9. Recoveries ranged from 20% to 165% and mean recoveries from 54% to 105%. Three high values and 8 low values were noted out of 90 tests. Indeno pyrene was not analyzed in 1986. In 1987, the average mean for PAHs was 70.3% with an average standard deviation of 20.8. Recoveries ranged from 6% to 142% and mean recoveries from 38% to 92%. No high values and 21 low values were noted out of 107 tests. Indeno pyrene was also not analyzed in 1987. Only fluoranthene was spiked in 1988. It's mean recovery was 122.1% with a standard deviation of 10.5. Recoveries ranged from 100% to 140%. No high or low values were noted out of 24 tests.

A comparison of 1985, 1986 and 1987 data showed that 1985 yielded the best data for PAHs followed by 1986 and 1987. The year 1987 yielded the lowest recoveries which could have been caused by the spiking and quantitation standards as explained in the organochlorines section. Fluoranthene, the only PAH spiked in 1988, yielded excellent QC data with a mean of 122% and a low standard deviation of 10.

Province wise (fig. 9), the average mean for PAHs for New Brunswick was 75.2% with an average standard deviation of 25.7. Recoveries ranged from 6% to 158% and mean recoveries from 40% to 100%. Two high values and 12 low values were noted out of 65 tests. For Nova Scotia, the average mean was 72.7% with an average standard deviation of 31.4. Recoveries ranged from 10% to 137% and mean recoveries from 48% to 89%. No high values and 9 low values were noted out of 48 tests. For Prince Edward Island, the average mean was 92.3% with an average standard deviation of 18.7. Recoveries ranged from 39% to 155% and mean recoveries from 49% to 110%. No high values and 3 low values were noted among 56 tests. For Newfoundland, the average mean was 84.9% with an average standard deviation of 21.5. Recoveries ranged from 34% to 165% and mean recoveries from 45% to 106%. One high value and 5 low values were noted among 52 tests.

All provinces thus yielded good PAH recoveries but variations in standard deviations were noted (see fig. 9). Prince Edward Island and Newfoundland clearly yielded better QC data for PAHs than New Brunswick and Nova Scotia which showed the highest deviations. The reasons

for this are not clear but possible causes include the spiking, handling of the samples and the different water types involved.

The distilled water QC spikes for PAHs gave an average mean of 81.8% with an average standard deviation of 20.7 (fig. 10). Recoveries ranged from 10% to 142% while mean recoveries ranged from 42% to 101%. No high values and 8 low values were noted out of 59 tests. The ground water spikes gave an average mean of 66.5% with an average standard deviation of 21.5. Recoveries ranged from 6% to 140% while mean recoveries ranged from 31% to 101%. No high values and 7 low values were noted out of 33 tests. The surface water spikes gave an average mean of 72.2% with an average standard deviation of 21.9. Recoveries ranged from 19% to 137% while mean recoveries ranged from 37% to 97%. No high values and 6 low values were noted out of 39 tests.

Figure 10 shows that distilled water clearly yielded better QC data for PAHs than natural water spikes. The most obvious reason is because distilled water is "cleaner" than natural water which may contain varied amounts of salts, metals, bacteria, organic matter, sediment, etc. These artifacts could have affected not only the stability of the PAHs in the samples but also the extraction efficiency, the cleanup steps and the analysis, resulting in lower apparent recoveries. Recoveries of benzo (a) pyrene in particular were much better in distilled water, while those of other PAHs were generally better. But fluoranthene recoveries were roughly the same in all three water types, indicating that some PAHs may be differently susceptible to water types and matrix effects.

2.5 Organophosphorus pesticides (OPs)

During the period 1985-88, 365 QC tests for OPs were performed on 77 samples. Five samples showed no data and 75 abnormal values were noted. Average mean was 83.5% with an average standard deviation of 26.7 (fig. 1). Recoveries ranged from 0% to 213% and mean recoveries from 31% to 110%.

It can be noted that only azinphos methyl, disyston, malathion and phorate were consistently spiked over the four years study. Most of the other OPs stopped being spiked after 1985.

The number of abnormal values and the data in general confirm the fact that OPs did present analytical difficulties. These difficulties were inherent to the nature of the compounds and to limitations in the methodology (Benoit et al, 1986). Low recoveries probably resulted from degradation in the spiked samples and by losses during the cleanup steps, while the few high values were most likely caused by difficulties with the chromatography or by interferences. In view of these facts, values reported for OPs in real samples should be viewed with caution.

On a yearly basis (table 2 and fig 11), in 1985, the average mean for OPs was 79.5% with an average standard deviation of 19.6. Recoveries ranged from 11% to 150% and mean recoveries from 31% to 104%. No high values and 11 low values were noted out of 104 tests. Imidan was

particularly troublesome in 1985 with a low mean recovery of 31%. Ethion, imidan, azinphos ethyl, methyl parathion, parathion and ronnel stopped being spiked after 1985. In 1986, the average mean was 106.7% with an average standard deviation of 48.5. Recoveries ranged from zero to 213% and mean recoveries from 73% to 125%. Ten high values and 10 low values were noted out of 78 tests. Diazinon stopped being spiked after 1986. In 1987, the average mean was 64.9% with an average standard deviation of 30.1. Recoveries ranged from 10% to 168% and mean recoveries from 47% to 108%. Four high values and 25 low values were noted out of 87 tests. In 1988, the average mean was 73.7% with an average standard deviation of 28.2. Recoveries ranged from 0% to 139% and mean recoveries from 54% to 88%. No high values and 13 low values were noted out of 96 tests.

Only azinphos methyl, disyston, malathion and phorate were consistently spiked over the four years of the survey. A comparison of those four parameters showed no definite trends. Recoveries seemed to have been randomly variable over the years. Some of the variability can possibly be ascribed to the different standards used over the years and to changes in the methodology, but OP analysis basically remained troublesome in all years. It is felt that 1985 yielded the best combination of recoveries and standard deviations followed by 1988 and 1987. The year 1986 yielded higher recoveries, but mostly as a result of many high abnormal values as reflected by the very high standard deviations. Because of too few measurements, diazinon recoveries were omitted from statistical calculations for the provinces.

Province wise (fig. 12), for New Brunswick, the average mean for OPs was 64.3% with an average standard deviation of 42.3. Recoveries ranged from 0% to 207% and mean recoveries from 49% to 84%. Two high values and 17 low values were noted out of 63 tests. For Nova Scotia, the average mean was 78.3% with an average standard deviation of 41.3. Recoveries ranged from 10% to 200% and mean recoveries from 61% to 96%. Three high values and 14 low values were noted out of 60 tests. For Prince Edward Island, the average mean was 86.0% with an average standard deviation of 39.3. Recoveries ranged from 0% to 170% and mean recoveries from 68% to 99%. Six high values and 7 low values were noted among 63 tests. For Newfoundland, the average mean was 83.8% with an average standard deviation of 39.0. Recoveries ranged from 15% to 213% and mean recoveries from 68% to 101%. Three high values and 9 low values were noted among 60 tests.

Prince Edward Island and Newfoundland thus yielded the best OP recoveries followed by Nova Scotia and New Brunswick. New Brunswick yielded particularly lower recoveries. The reasons for this are not clear but field techniques and preservation may be at fault. All provinces showed similar but high standard deviations, again reflecting the difficulties in analyzing OPs.

The distilled water QC spikes for OPs gave an average mean of 68.3% with an average standard deviation of 32.1 (fig. 13). Recoveries ranged from 7% to 166% while mean recoveries ranged from 52% to 88%. Three high values and 14 low values were noted out of 76 tests. The ground water spikes gave an average mean of 70.8% with an average standard deviation of 33.3. Recoveries ranged from 0% to 168% while mean recoveries ranged from 51% to 106%. One high value and 12 low values were noted out of 51 tests. The surface water spikes gave an average

mean of 70.2% with an average standard deviation of 31.5. Recoveries ranged from 10% to 148% while mean recoveries ranged from 49% to 95%. No high value and 12 low values were noted out of 56 tests.

There were thus minimal differences in OP recoveries between water types, indicating differences in water matrix seemed to have little effects on the recoveries of malathion, phorate, disyston and azinphos methyl from hexane preserved samples. All three water types showed acceptable recoveries but also the high standard deviations associated with OP analysis.

2.6 Chlorinated phenols (CPs)

During the period 1985-88, 549 QC tests for CPs were performed on 77 samples. Seven samples showed no data and 24 abnormal values were noted. The average mean was 91.9% with an average standard deviation of 23.2 (fig. 1). Recoveries ranged from 0% to 172% and mean recoveries from 78% to 113%.

Recoveries of chlorophenol spikes were thus very good overall, with very good means and good standard deviations. No problem compounds were noted.

On a yearly basis (table 2 and fig. 14), in 1985, the average mean for CPs was 92.6% with an average standard deviation of 20.9. Recoveries ranged from 39% to 172% and mean recoveries from 78% to 113%. One high value and one low value were noted out of 130 tests. In 1986, the average mean was 100.6% with an average standard deviation of 25.6. Recoveries ranged from 0% to 160% and mean recoveries from 90% to 111%. Two high values and 2 low values were noted out of 133 tests. In 1987, the average mean was 89.3% with an average standard deviation of 21.6. Recoveries ranged from 33% to 140% and mean recoveries from 84% to 99%. No high value and 6 low values were noted out of 153 tests. In 1988, the average mean was 75.2% with an average standard deviation of 22.8. Recoveries ranged from 22% to 130% and mean recoveries from 70% to 87%. No high values and 12 low values were noted out of 133 tests.

The recoveries and standard deviations for CPs were thus good in all years, with 1988 yielding lower but acceptable recoveries. Most low values occurred in late 1988 and were distributed among all CPs analyzed that year, indicating a problem with the spiking standard or with the methodology during that period.

Province wise (fig. 15), for New Brunswick, the average mean for CPs was 100.8% with an average standard deviation of 17.3. Recoveries ranged from 63% to 147% and mean recoveries from 97% to 113%. No high or low values were noted out of 126 tests. For Nova Scotia, the average mean was 81.7% with an average standard deviation of 26.5. Recoveries ranged from 22% to 150% and mean recoveries from 76% to 88%. No high values and 12 low values were noted out of 98 tests. For P.E.I., the average mean was 89.8% with an average standard deviation of 30.1. Recoveries ranged from 0% to 160% and mean recoveries from 77% to 104%. Two high values and 3 low values were noted out of 90 tests. For Newfoundland, the average mean was

78.6% with an average standard deviation of 22.5. Recoveries ranged from 24% to 153% and mean recoveries from 72% to 88%. No high values and 4 low values were noted out of 105 tests.

All provinces yielded good QC data but New Brunswick clearly yielded the best data for CPs. There are no clear reasons for this, but transport time and water types may have played a role. Prince Edward Island yielded slightly higher recoveries than Nova Scotia and Newfoundland but showed higher standard deviations. Newfoundland yielded QC data similar to Nova Scotia but showed better standard deviations.

The distilled water QC spikes for CPs gave an average mean of 91.1% with an average standard deviation of 21.7 (fig. 16). Recoveries ranged from 33% to 140% and mawn recoveries from 86% to 101%. No high values and 6 low values were noted out of 118 tests. The ground water spikes gave an average mean of 85.8% with an average standard deviation of 21.0. Recoveries ranged from 39% to 127% and mean recoveries from 82% to 100%. No high values and 1 low values were noted out of 84 tests. The surface water spikes gave an average mean of 68.0% with an average standard deviation of 21.1. Recoveries ranged from 22% to 113% and mean recoveries from 64% to 77%. No high values and 11 low values were noted out of 84 tests.

The recoveries of CPs were therefore excellent in distilled water and ground water but markedly lower in surface water spikes. The reasons for this are not clear but may have to do with the higher microorganism content of surface waters in general, since the hydroxy group on chlorinated phenols molecules makes them more susceptible to biodegradation than regular chlorinated compounds like CBs. It is also possible that the higher organic content in surface waters may have interfered with the derivatization step or other part of the analytical method. Water matrix may thus have had a detrimental effect on the recoveries of CPs from unpreserved samples.

2.7 Carbamates

During the period 1985-88, 160 QC tests for carbamates were performed on 77 sample. Twenty five samples showed no data and 29 abnormal values were noted. Average mean was 74.3% with an average standard deviation of 30.0 (fig. 1). Recoveries ranged from 0% to 125% and mean recoveries from 50% to 86%.

Although the overall performance for carbamate spikes was good, they seemed to have presented difficulties as shown by the number of low values and the relatively high standard deviations. Aldicarb sulfoxide in particular seemed to have been troublesome, showing 17 low values out of 32 measurements. Gaps in carbamate analysis were noted and were due to problems with lab instruments.

Carbaryl, the only carbamate analyzed in 1985, awelded good QC data with a mean recovery of 84% and an average standard deviation of 20 (fig. 17). Recoveries ranged from 50% to 100% and no high or low values were noted out of 10 tests. In 1986, the average mean for carbamates

was 80.7% with an average standard deviation of 8.5. Recoveries ranged from 64% to 120% and mean recoveries from 74% to 103%. No high or low values were noted out of 46 tests. Only carbaryl was analyzed during the first half of 1986. Carbamates were not analyzed in 1987 due to problems with laboratory instruments. In 1988, the average mean was 68.9% with an average standard deviation of 31.9. Recoveries ranged from 0% to 125% and mean recoveries from 35% to 86%. No high value and 30 low values were noted out of 104 tests.

Very good QC data were thus obtained for those carbamates analyzed in 1985 and 1986. On the other hand, carbamates seem to have been troublesome in 1988, yielding lower recoveries, higher standard deviations and a higher number of low values than 1986. Aldicarb sulfoxide was particularly troublesome in 1988 with a low mean of 35%. Even carbaryl, which yielded good QC data in 1985 and 1986, showed erratic recoveries in 1988. Carbamates were analyzed by a post-column derivatization HPLC technique that presented some technical difficulties. The derivatization step is especially prone to problems and may have been the cause of erratic recoveries. The lack of sample preservation may also have been at fault.

Province wise (fig. 18), for New Brunswick, the average mean for carbamates was 83.9% with an average standard deviation of 23.5. Recoveries ranged from 0% to 125% and mean recoveries from 64% to 97%. No high values and 5 low values were noted out of 45 tests. For Nova Scotia, the average mean was 74.1% with an average standard deviation of 36.4. Recoveries ranged from 0% to 125% and mean recoveries from 46% to 89%. No high values and 7 low values were noted out of 33 tests. For Prince Edward Island, the average mean was 61.5% with an average standard deviation of 32.1. Recoveries ranged from 0% to 102% and mean recoveries from 38% to 79%. No high values and 9 low values were noted out of 31 tests. For Newfoundland, the average mean was 75.1% with an average standard deviation of 21.0. Recoveries ranged from 18% to 120% and mean recoveries from 42% to 86%. No high values and 8 low values were noted out of 41 tests.

New Brunswick thus yielded better QC data for carbamates, followed by Newfoundland, Nova Scotia and Prince Edward Island. But the differences between the provinces may simply be due to the low number of measurements, from 3 to 11 per parameter, making the statistical comparison questionable at best.

The distilled water QC spikes for carbamates gave an average mean of 64.1% with an average standard deviation of 35.3 (fig 19). Recoveries ranged from 0% to 125% and mean recoveries from 26% to 91%. No high values and 13 low values were noted out of 36 tests. The ground water spikes gave an average mean of 78.0% with an average standard deviation of 21.2. Recoveries ranged from 25% to 108% and mean recoveries from 41% to 93%. No high values and 3 low values were noted out of 32 tests. The surface water spikes gave an average mean of 72.9% with an average standard deviation of 16.5. Recoveries ranged from 18% to 125% and mean recoveries from 24% to 93%. No high values and 9 low values were noted out of 32 tests.

Recoveries of carbamates thus seemed better in ground water and surface water than in distilled water spikes, but the low number of measurements (between 4 and 8 for each parameter) may explain the differences in statistics.

3. Conclusion

The QC data presented in this report was examined by year, province, and by water types (distilled vs ground vs surface). Trends were assessed and problem areas were discussed.

The QC results showed that good overall performance was achieved for the analysis of OCs in water. The analytical process was improved over the years to the point where results for OCs, especially in later years, were considered quite reliable. Of the OCs analyzed in 1987 and 1988, none seemed to present serious analytical problems. Some variations in recoveries between provinces were noted, so continued efforts should be made to standardize the collection, spiking and preservation process. Recoveries of OCs were good in all three water types but were slightly better in ground water than in distilled or surface water.

In the case of chlorobenzenes, the QC results showed that recoveries of lower substituted CBs were biased low, probably because of their higher volatility. This means that results, if any, reported for those CBs in real samples, probably represented low estimates of the real amounts. Other CBs showed good QC data throughout the years of the study so that results can be considered reliable. Differences in CB recoveries between provinces suggested that transport time may have had a detrimental effect. Newfoundland for example, the province farthest from the laboratory, showed the lowest CB recoveries with the highest deviations. Differences in water types seemed to have little effect on CB recoveries from hexane preserved samples. Distilled water, the "cleanest" of the three water types, showed a slightly better overall standard deviation.

PCBs stopped being spiked after 1985 but available QC data showed good performance was achieved in 1985 for PCB analysis.

PAHs showed variable recoveries during the study. Some like fluoranthene, the only PAH spiked in all years, showed good overall recoveries, especially in 1988, so that results for this compound can be considered reliable. Others like B(k)Fl or indeno perylene seemed to have presented difficulties and stopped being analyzed at some point in the study. Results for those PAHs should be viewed with caution. All PAHs but fluoranthene stopped being analyzed after 1987. Differences in PAH recoveries between provinces were noted and may be linked to field techniques, water types and/or the spiking solutions. Newfoundland and Prince Edward Island, the provinces farthest from the lab, yielded the best QC data for PAHs. Water types did seem to have an effect on PAHs as evidenced by the better recoveries generally obtained from distilled water compared to natural water spikes.

The QC data showed that OPs were among the worst performers in this study. Azinphos methyl, disyston, malathion and phorate, the only OPs analyzed in all years, showed variable if not erratic recoveries over the years. Results for OPs should thus be viewed with caution. As in the case of PAHs, recoveries of OPs were better from Newfoundland and Prince Edward Island samples. No significant differences were noted in OP recoveries between distilled water and natural water spikes.

Overall recoveries of CPs were very good in all years of the study and no problem compounds were noted. Results for CPs can therefore be considered reliable. Newfoundland samples showed slightly lower CP recoveries indicating possible degradation due to longer transit times. This is supported by the lower CP recoveries obtained from natural water, and especially surface water, compared to distilled water spikes. Water matrix and sitting time may thus have had a detrimental effect on unpreserved CP samples.

The QC data clearly showed that carbamates were problematic. Problems with lab instrumentation resulted in no carbamates being analyzed in 1987 and only carbaryl being analyzed in 1985 and part of 1986. Carbamate recoveries were generally acceptable and somewhat better in 1985 and 1986 than in 1988. Aldicarb sulfoxide seemed to have been especially troublesome in 1988, yielding the worst QC data in this project. Carbamates results should therefore be viewed with caution. Because of the low number of measurements, no definite comparisons could be made between provinces and water types.

4. Recommendations

In the course of conducting field work and evaluating the QC data generated by this survey, some observations were made that can be addressed by recommendations.

It is recommended that:

- a preservation scheme for CP samples should be devised and evaluated, especially if long delays are expected between sampling and analysis. QC data showed evidence of degradation as lower recoveries were obtained from Newfoundland samples and natural water samples. Similarly, a preservation scheme for carbamate samples should be implemented as QC data showed evidence of degradation.

- bottles with teflon lined caps should be used exclusively for sampling organics, especially if the samples are preserved with a solvent like hexane. Caps with a piece of aluminum foil often do not provide a tight seal and can leak solvent, causing losses since most organic compounds in the sample will migrate to the solvent.

- the spiking solutions should be kept in small but filled bottles, as small volumes kept in large bottles tend to evaporate faster resulting in more concentrated solutions. It is also recommended that spiking solutions be kept cool and returned to the lab after the sampling trip to be checked for evaporation and contamination if need be.

- alternatives to the HPLC post-derivatization method for carbamates should be explored as it seems to be a weak link in the protocol. With the advent of new bonded phases, megabore open tubular columns and automated on-column injectors, a GC or GC-MSD method may be more practical.

It is also suggested that spiked samples be kept in separate coolers to prevent contamination of other samples. Also, syringes with teflon tipped plungers could be used for spiking instead of the syringes now in use, as they produce less bubbles in the body of the syringe. The size of the syringes should be kept at 100 uL as it helps reduce the risks of accidentally spiking larger amounts in the samples.

Although PAH analysis by the HPLC fluorescence detection method was generally successful, an alternate GC-MSD method is currently available (NWQL) that provides simultaneous quantitation and confirmation of a greater number of PAHs at equal or better detection limits.

Finally, continued efforts should be made to improve OP analysis.

5. References

Benoit, F.M., G.L. LeBel (1986). Precision and Accuracy of Concurrent Multicomponent Multiclass Analysis of Drinking Water Extracts by GC/MS. Bulletin of Environmental Contamination and Toxicology 37:688-691.

NWQL, National Water Quality Laboratory, Environment Canada, Canada Centre for Inland Waters, Burlington, Ontario.

Environment Canada (1989). Atlantic Region Federal-Provincial Toxic Chemical Survey of Municipal Drinking Water Sources, 1985-1988. Environment Canada, Water Quality Branch, Atlantic Region, Moncton, N.B.

Table 1: Overall recoveries of organic spikes.

	average mean %	average stdev %	mean rec. low %	mean rec. high %	recoveries low %	recoveries high %	# of tests
OCs	94.0	29.8	75	144	27	242	859
CBs	72.2	19.8	55	91	4	143	270
PCBs	75.0	8.0	-	-	65	90	10
PAHs	82.4	28.1	55	100	6	165	281
OPs	83.5	26.7	31	110	0	213	365
CPs	91.9	23.2	78	113	0	172	549
Carb	74.3	30.0	50	86	0	125	160

Table 2: Recoveries of organic spikes by years.

	year	average mean %	average stdev %	mean rec. low %	mean rec. high %	recoveries low %	recoveries high %	# of tests
OCs	1985	109.6	38.4	77	169	28	242	170
	1986	72.3	18.2	42	104	27	228	216
	1987	74.8	15.7	56	105	29	141	209
	1988	98.6	13.9	88	114	43	158	264
CBs	1985	54.6	12.1	46	65	31	105	30
	1986	67.0	18.1	50	77	20	115	56
	1987	65.8	18.3	48	91	4	143	92
	1988	84.8	15.6	68	96	31	122	92
PCBs	1985	75.0	8.0	-	-	65	90	10
	1986	-	-	-	-	-	-	-
	1987	-	-	-	-	-	-	-
	1988	-	-	-	-	-	-	-
PAHs	1985	92.5	26.2	73	110	35	136	60
	1986	88.5	26.9	54	105	20	165	90
	1987	70.3	20.8	38	92	6	142	107
	1988	122.1	10.5	-	-	100	140	24
		(only fluoranthene in 1988)						
OPs	1985	79.5	19.6	31	104	11	150	104
	1986	106.7	48.5	73	125	0	213	78
	1987	64.9	30.1	47	108	10	168	87
	1988	73.7	28.2	54	88	0	139	96
CPs	1985	92.6	20.9	78	113	39	172	130
	1986	100.6	25.6	90	111	0	160	133
	1987	89.3	21.6	86	99	33	140	153
	1988	75.2	22.8	70	87	22	130	133
Carb	1985	84.0	20.0	-	-	50	100	10
		(only carbaryl in 1985)						
	1986	80.7	8.5	74	103	64	120	46
	1987	-	-	-	-	-	-	-
	1988	68.9	31.9	35	86	0	125	104

Table 3: Recoveries of organic spikes by provinces.

	province	average mean %	average stdev %	mean rec. low %	mean rec. high %	recoveries low %	recoveries high %	# of tests
OCs	NB	98.5	22.1	70	124	29	228	204
	NS	80.5	22.4	67	102	29	158	169
	PEI	79.0	18.8	65	98	27	144	147
	NFLD	80.0	18.4	72	101	34	130	169
CBs	NB	76.6	16.5	59	98	40	122	68
	NS	78.6	19.8	58	102	37	143	59
	PEI	69.2	15.9	54	82	31	115	46
	NFLD	69.1	23.5	51	82	4	121	67
PCBs		insufficient information						
PAHs	NB	75.2	25.7	40	100	6	158	65
	NS	72.7	31.4	48	89	10	137	48
	PEI	92.3	18.7	49	110	39	155	56
	NFLD	84.9	21.5	45	106	34	165	52
OPs	NB	64.3	42.3	49	84	0	207	63
	NS	78.3	41.3	61	96	10	200	60
	PEI	86.0	39.3	68	99	0	170	63
	NFLD	83.8	39.0	68	101	15	213	60
CPs	NB	100.8	17.3	97	113	63	147	126
	NS	81.7	26.5	76	88	22	150	98
	PEI	89.8	30.1	77	104	0	160	90
	NFLD	78.6	22.5	72	88	24	153	105
Carb	NB	83.9	23.5	64	97	0	125	45
	NS	74.1	36.4	46	89	0	125	33
	PEI	61.5	32.1	38	79	0	102	31
	NFLD	75.1	21.0	42	86	18	120	41

Table 4: Recoveries of organic spikes by water types.

	water type	average mean %	average stdev %	mean rec. low %	mean rec. high %	recoveries low %	recoveries high %	# of tests
OCs	Dist	85.6	19.1	71	109	32	153	176
	Grnd	93.6	17.5	83	118	29	150	143
	Surf	85.9	19.6	71	103	37	158	154
CBs	Dist	73.8	18.0	55	94	27	133	76
	Grnd	74.5	20.3	59	90	31	122	48
	Surf	77.7	22.6	60	97	4	143	60
PCBs		insufficient information						
PAHs	Dist	81.8	20.7	42	101	10	142	59
	Grnd	66.5	21.5	31	101	6	140	33
	Surf	72.2	21.9	37	97	19	137	39
OPs	Dist	68.3	32.1	52	88	7	166	76
	Grnd	70.8	33.3	51	106	0	168	51
	Surf	70.2	31.5	49	95	10	148	56
CPs	Dist	91.1	21.7	86	101	33	140	118
	Grnd	85.8	21.0	82	100	39	127	84
	Surf	68.0	21.1	64	77	22	113	84
Carb	Dist	64.1	35.3	26	91	0	125	36
	Grnd	78.0	21.2	41	93	25	108	32
	Surf	72.9	16.5	24	93	18	125	32

Figure 1: Overall recoveries of organic toxic chemicals in spiked samples.

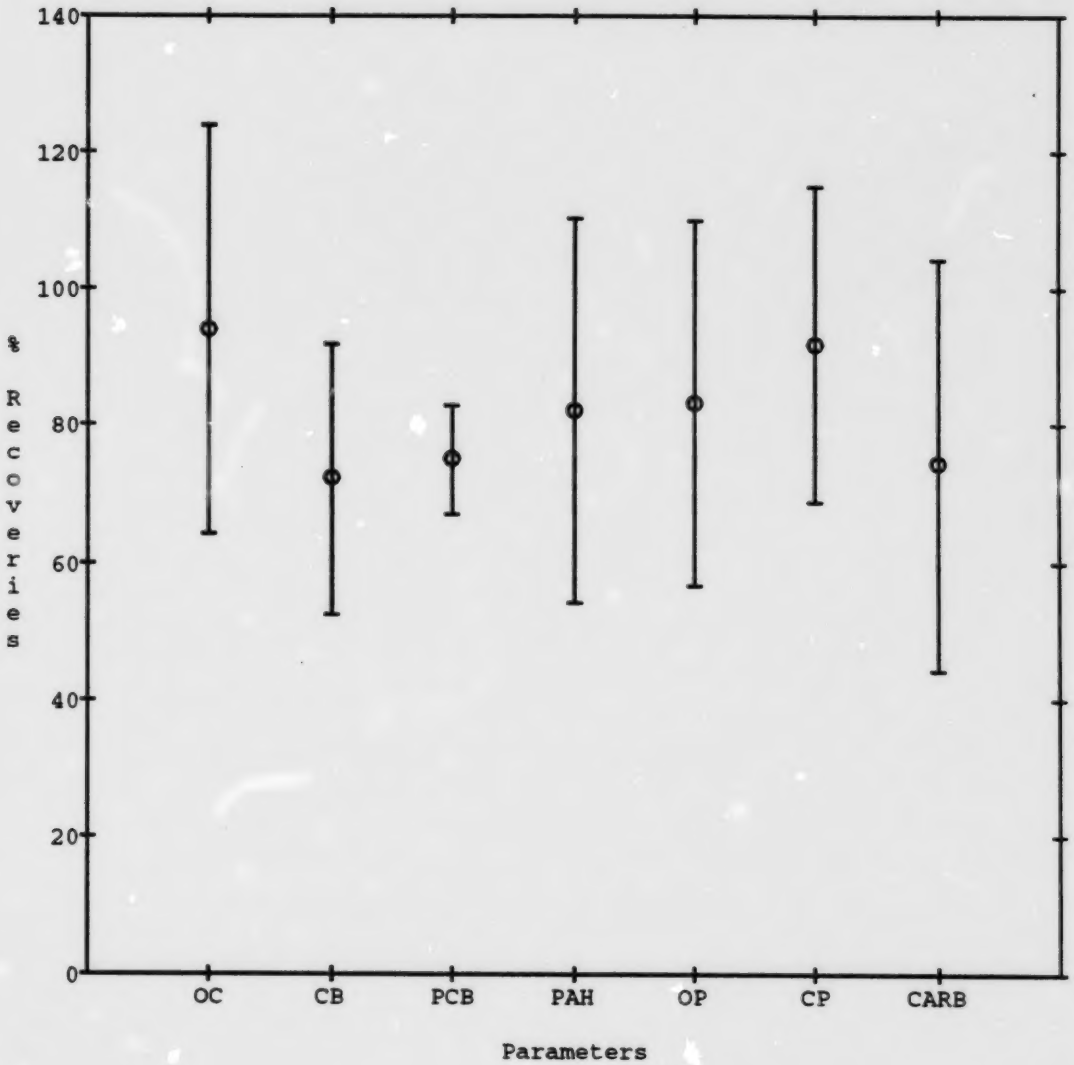


Figure 2: Recoveries of organochlorines by year.

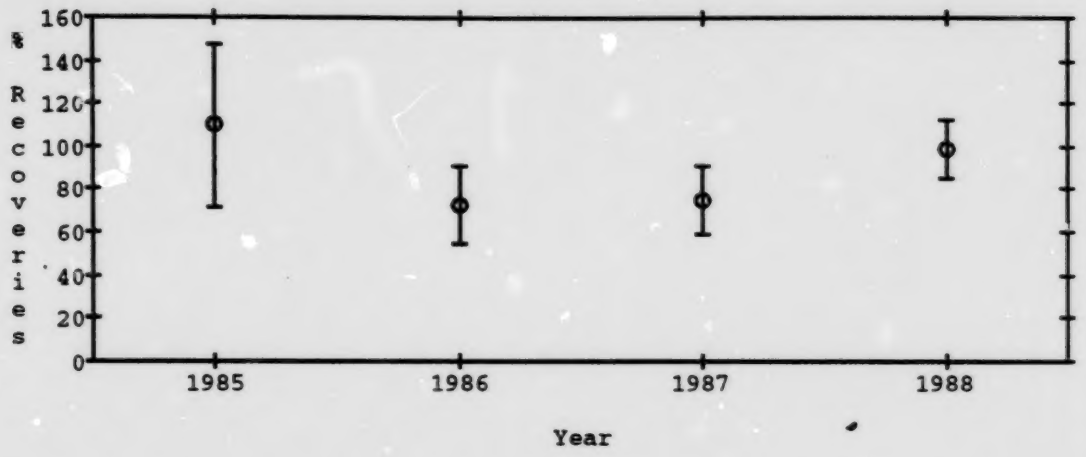


Figure 3: Recoveries of organochlorines by province.

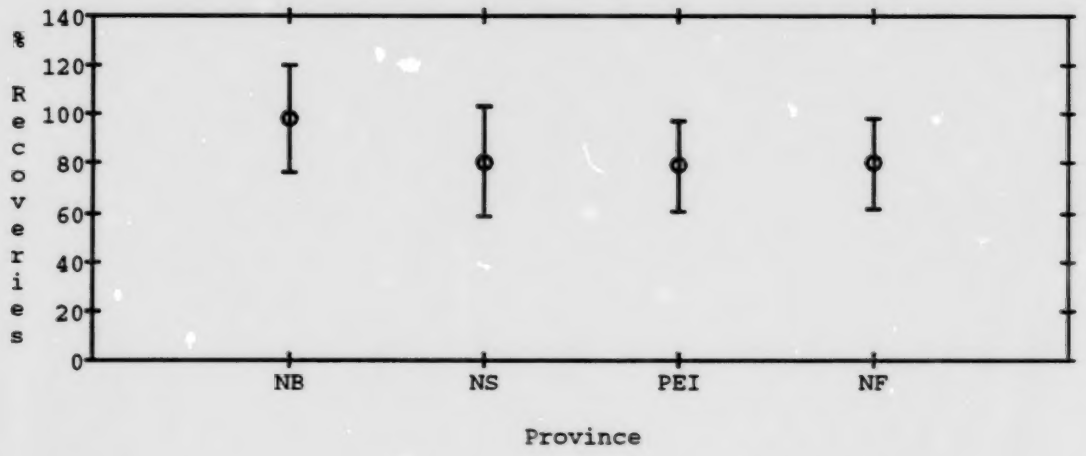


Figure 4: Recoveries of organochlorines by water type.

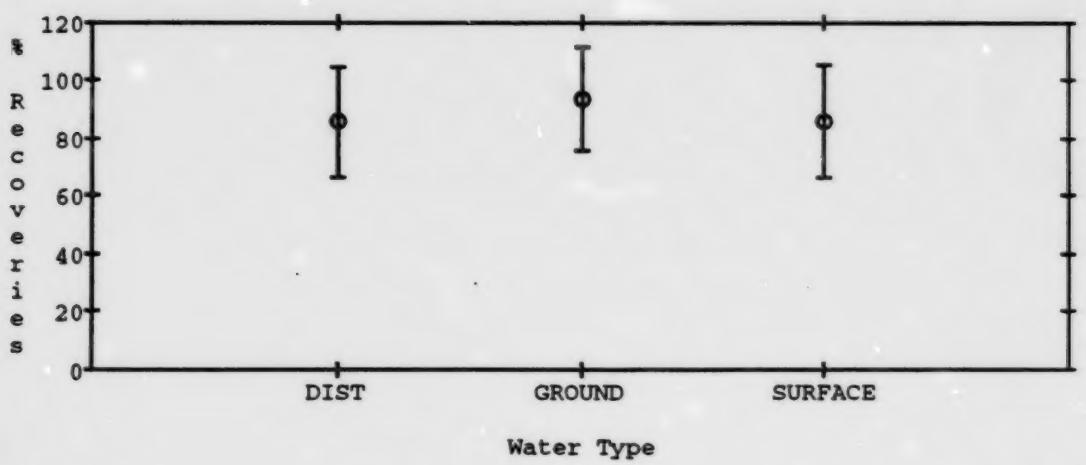


Figure 5: Recoveries of chlorobenzenes by year.

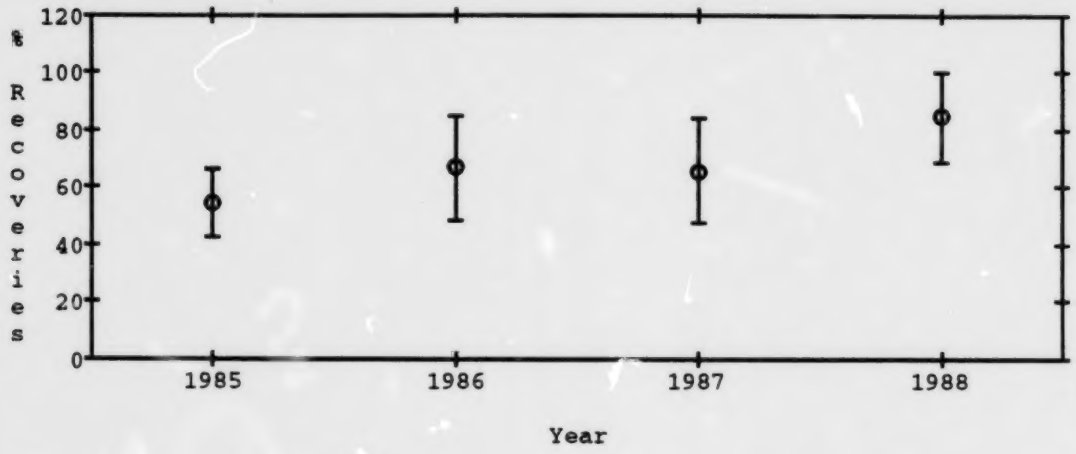


Figure 6: Recoveries of chlorobenzenes by province.

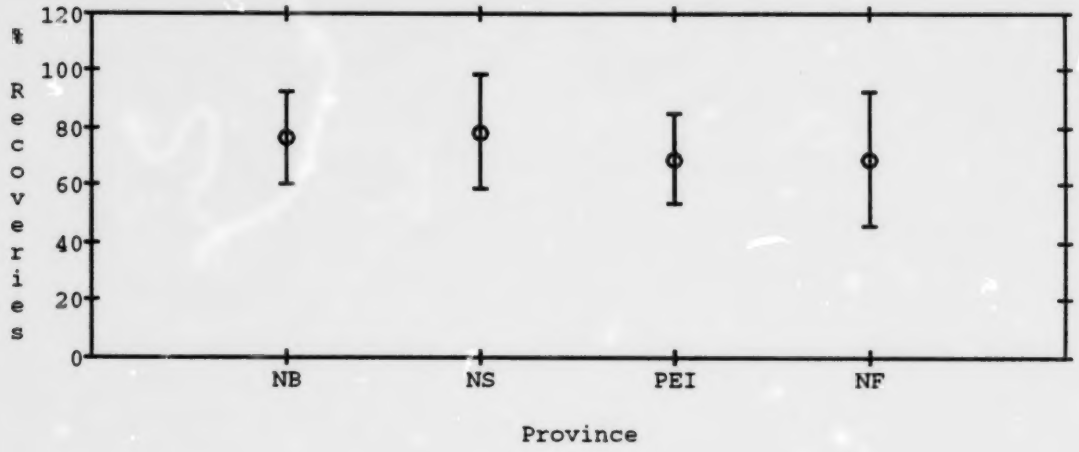


Figure 7: Recoveries of chlorobenzenes by water type.

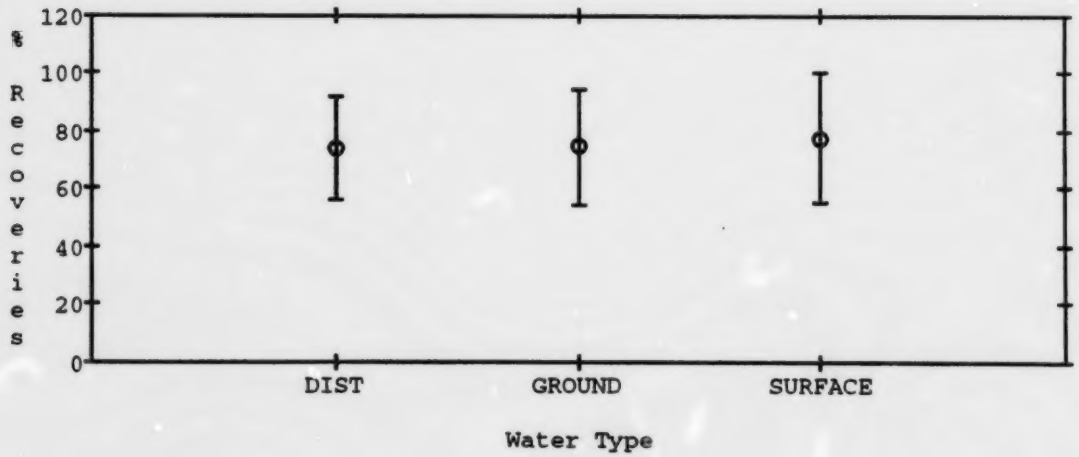


Figure 8: Recoveries of polynuclear aromatic hydrocarbons by year.

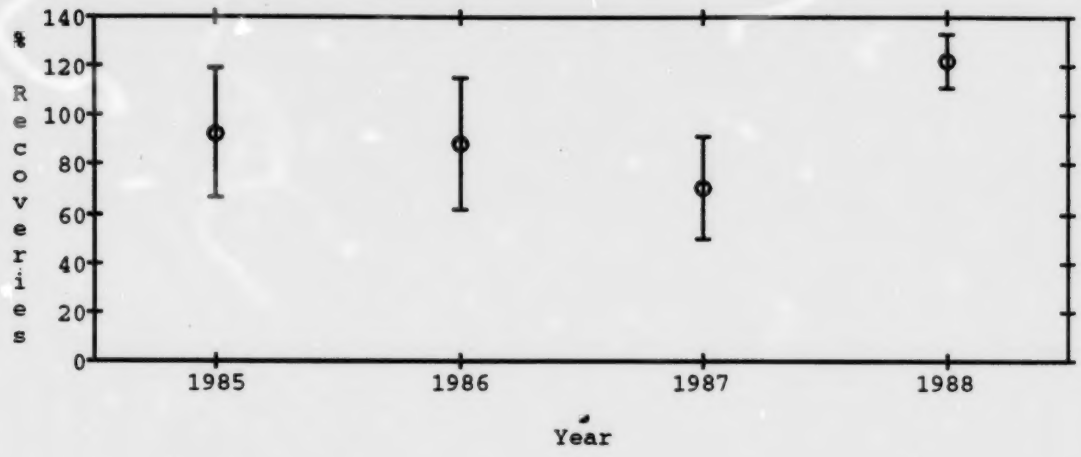


Figure 9: Recoveries of polynuclear aromatic hydrocarbons by province.

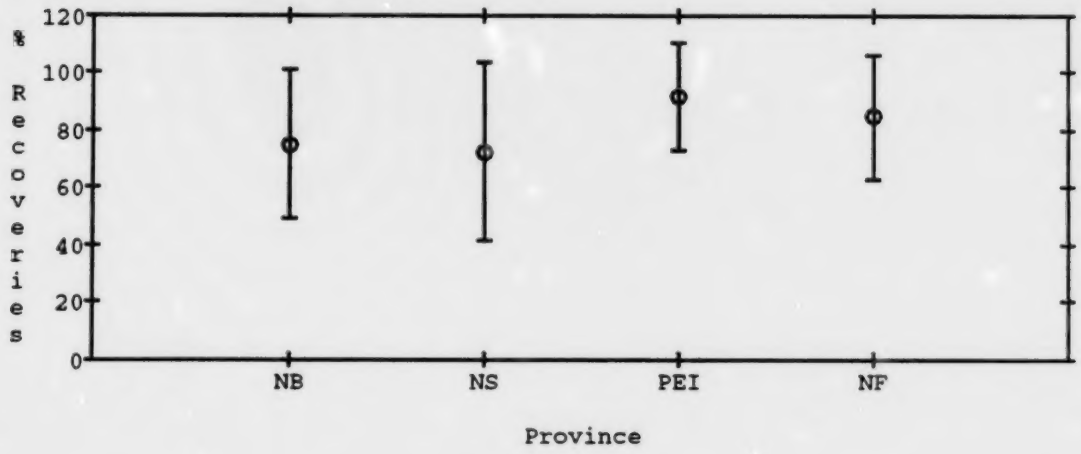


Figure 10: Recoveries of polynuclear aromatic hydrocarbons by water type.

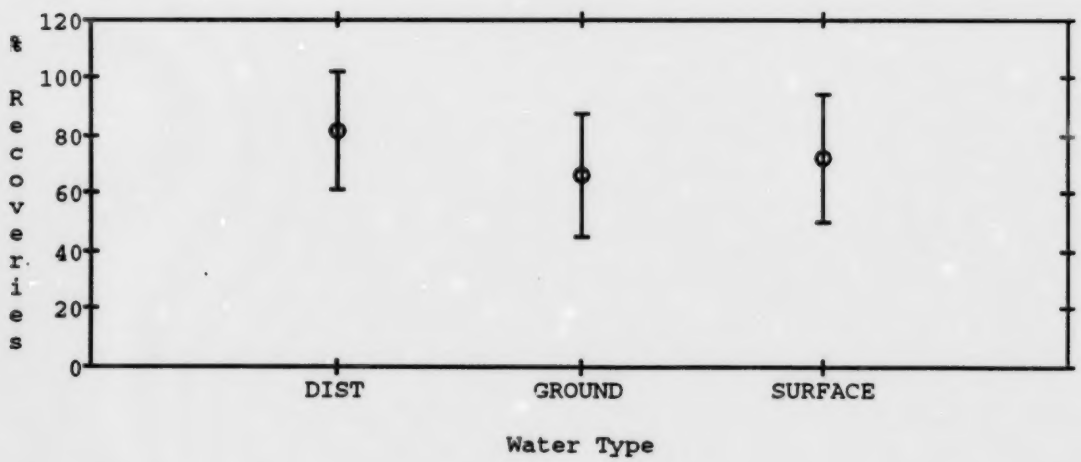


Figure 11: Recoveries of organophosphorus pesticides by year.

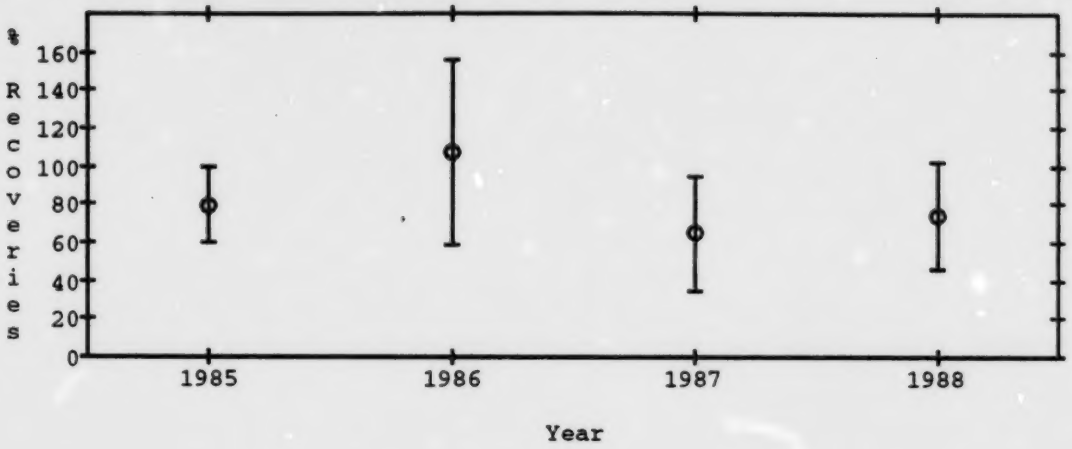


Figure 12: Recoveries of organophosphorus pesticides by province.

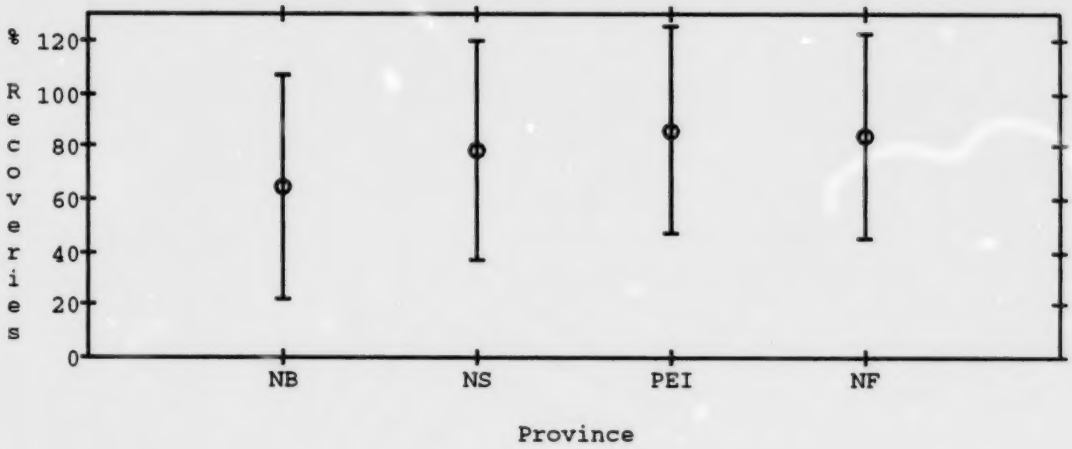


Figure 13: Recoveries of organophosphorus pesticides by water type.

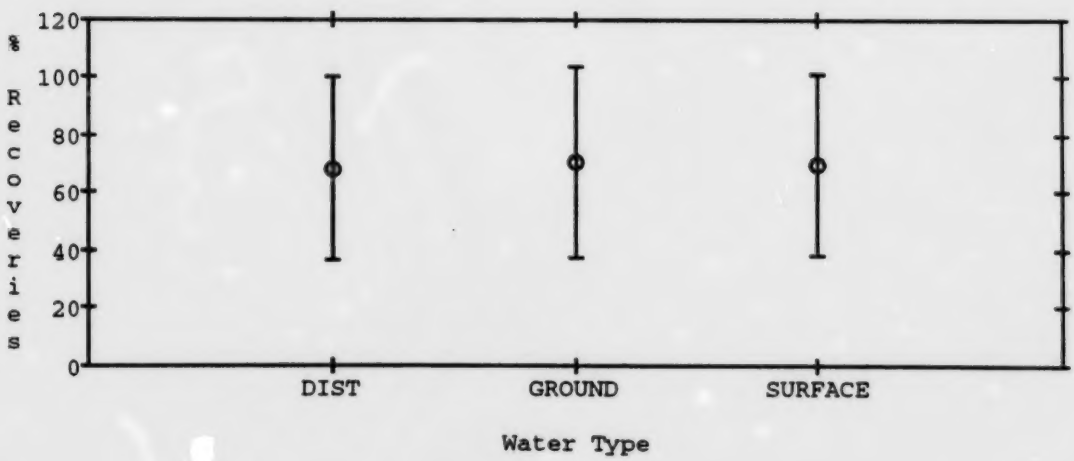


Figure 14: Recoveries of chlorinated phenols by year.

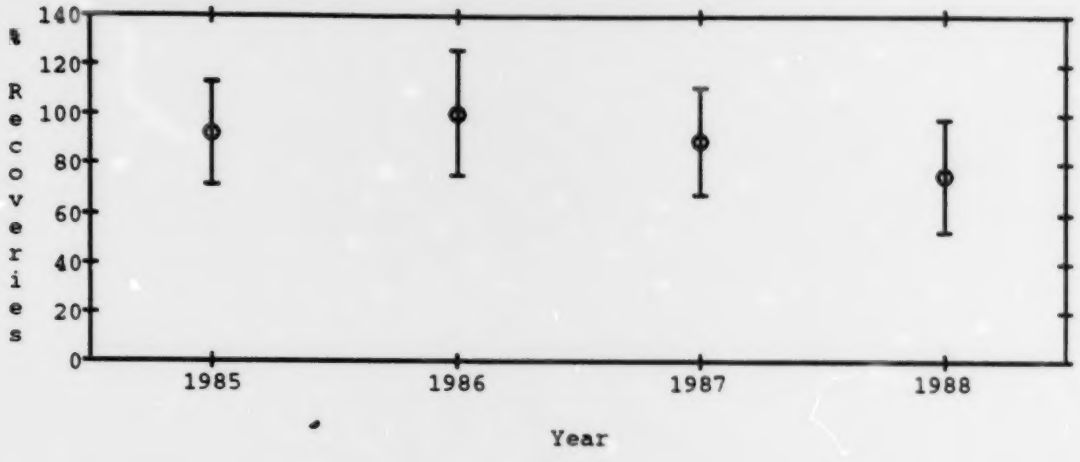


Figure 15: Recoveries of chlorinated phenols by province.

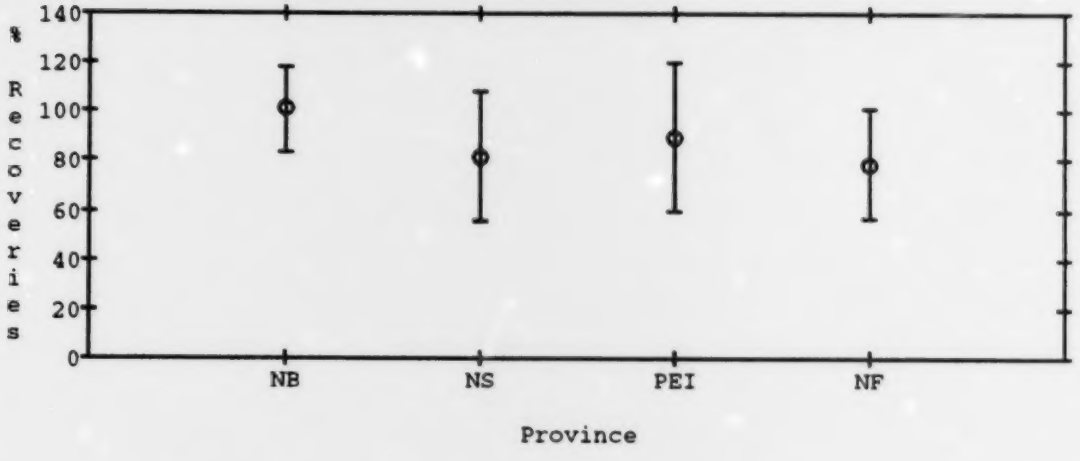


Figure 16: Recoveries of chlorinated phenols by water type.

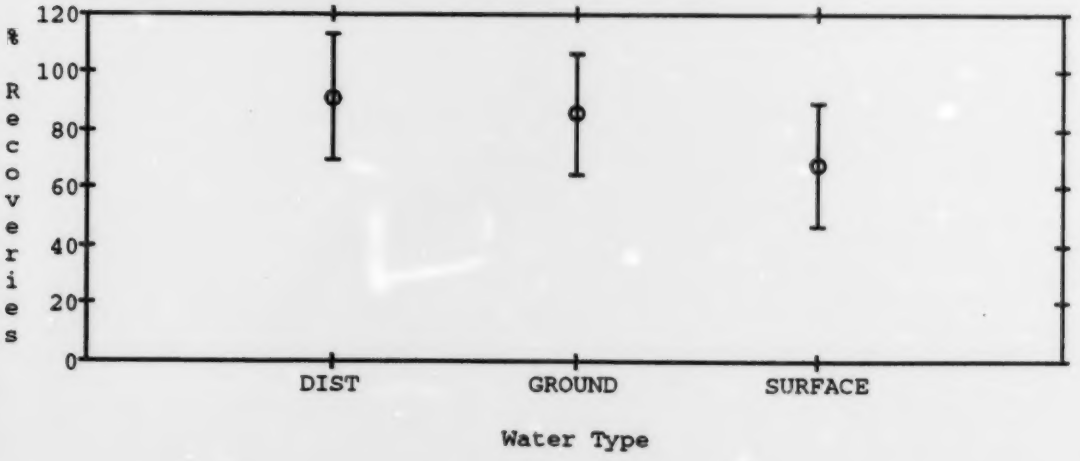


Figure 17: Recoveries of carbamates by year.

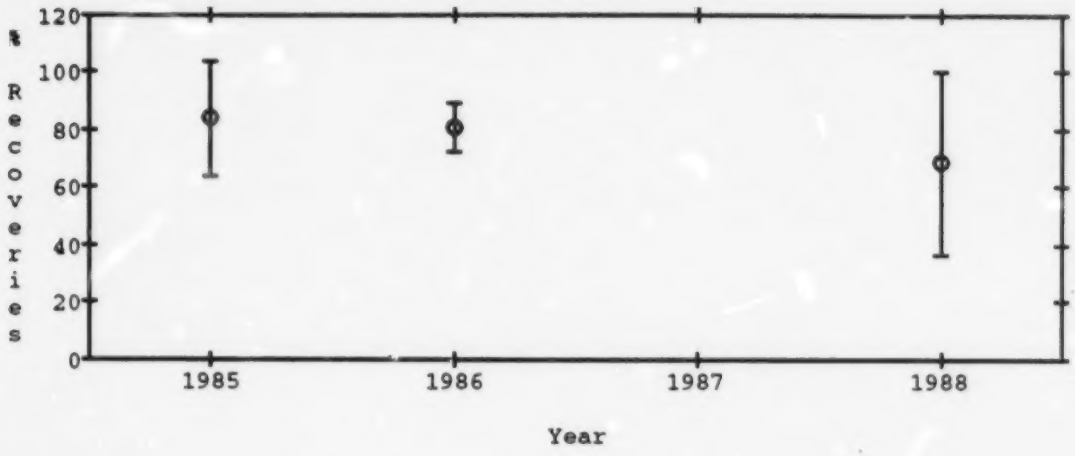


Figure 18: Recoveries of carbamates by province.

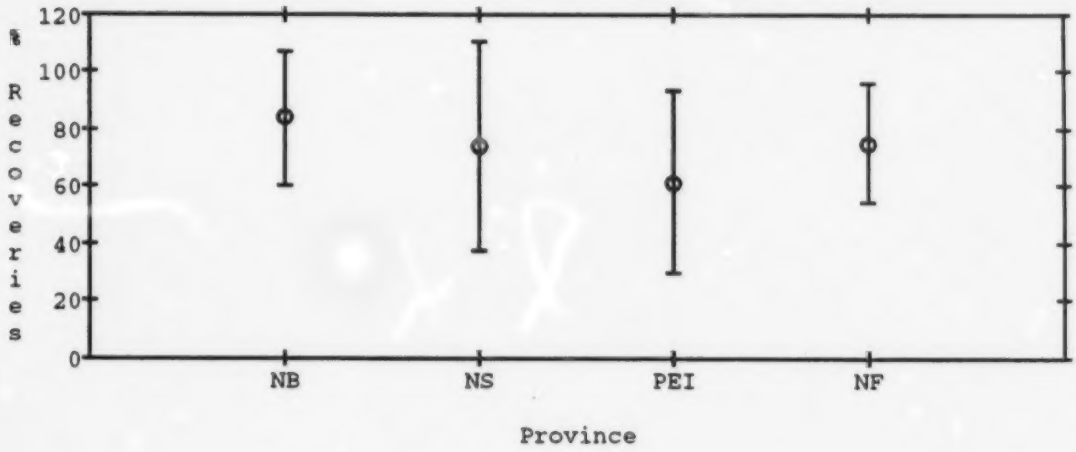
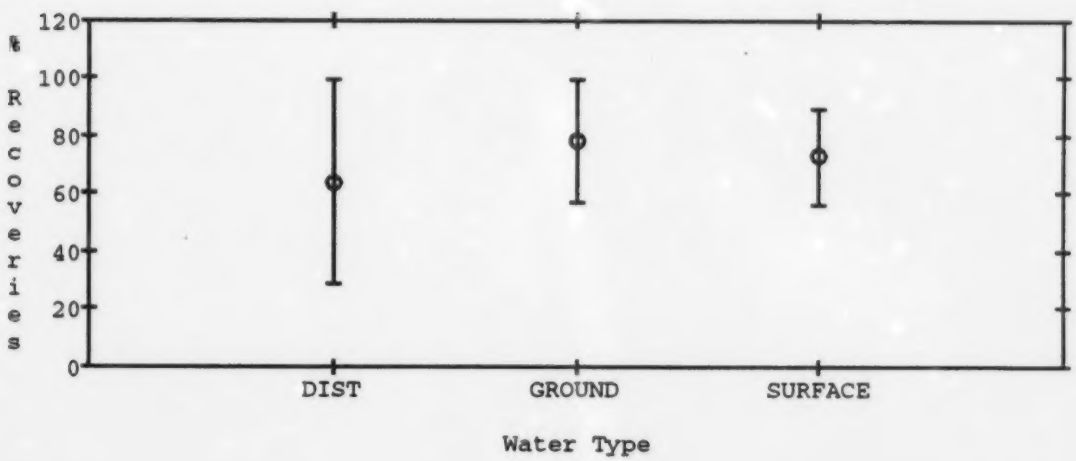


Figure 19: Recoveries of carbamates by water type.



APPENDIX A

Municipal drinking water survey, quality control organic spikes:
recoveries and overall statistics.

0	1 PROV	2 TYPE	3 STN	4 SAMPLE	5 SDATE	6 1,3-DCB	7 1,3,5-TCB	8 1,2,3,4-TeCB	9 HCB
1	NB	NAT	01NB01BJFS15	500670	06-JUN-85	53	42	44	
2	NB	NAT	01NB01BJFS15	500671	06-JUN-85	73	42	36	
3	NF	NAT	01NF02ZGSPIK	500850	20-JUN-85	50	43	31	
4	NB	NAT	00NB01ADSPIK	501757	09-OCT-85	58	44	65	
5	NB	NAT	00NB01ADSPIK	501758	09-OCT-85	57	50	70	
6	NS	NAT	01NS01EGFS03	501956	23-OCT-85	50	47	100	
7	NS	NAT	01NS01EGFS03	501957	23-OCT-85	50	50	80	
8	NS	NAT	01NS01EGFS03	501958	23-OCT-85	50	50	105	
9	NF	NAT	00NF000SPIKE	502172	07-NOV-85	47	42	55	
10	NF	NAT	00NF000SPIKE	502173	07-NOV-85	47	47	60	
11	PE	NAT	10PE01CBFS18	600538	21-MAY-86	72	79	115	
12	PE	NAT	10PE01CBFS18	600539	21-MAY-86	78	89	97	
13	NS	NAT	00NS01DGFS59	600815	04-JUN-86				
14	NS	NAT	00NS01DGFS59	600831	04-JUN-86	64	104	70	
15	NB	NAT	10NB01BTFS03	600968	13-JUN-86	54	46	72	
16	NB	NAT	10NB01BTFS03	600969	13-JUN-86	40	43	59	
17	NF	NAT	01NF02YOFS19	601100	12-JUN-86	48	75	68	68
18	NF	NAT	01NF02YOFS19	601101	12-JUN-86	41	43	50	
19	PE	NAT	10PE01CCFS55	601819	09-SEP-86				
20	PE	NAT	01PE000SPIKE	601820	09-SEP-86				
21	NS	NAT	01NS01DEFS14	601977	25-SEP-86	39	61	69	77
22	NS	NAT	01NS01DEFS14	601978	25-SEP-86	48	82	82	95
23	NB	NAT	01NB01BUFS02	601979	25-SEP-86	48	64	74	
24	NB	NAT	10NB01BOFS06	602346	24-OCT-86	70	50	90	103
25	NB	NAT	10NB01BOFS06	602346	24-OCT-86	70	50	90	
26	NB	NAT	01NB01BUFS02	602347	24-OCT-86	56	64	87	100
27	NF	NAT	01NF02YOFS18	602378	23-OCT-86	26	71	61	60
28	NF	DIS	01NF02YOFD18	602379	23-OCT-86	29	71	59	60
29	NF	NAT	01NF02YOFS18	602380	23-OCT-86	20	64	58	50
30	PE	DIS	10PE01CDFD03	700492	20-MAY-87	51	71	73	106
31	PE	DIS	10PE01CDFD03	700493	20-MAY-87	48	68	63	88
32	PE	NAT	10PE01CDFS03	700494	20-MAY-87	48	71	70	105
33	NB	NAT	10NB01BCFS01	700663	25-MAY-87	53	71	73	110
34	NB	NAT	10NB01BCFS01	700664	25-MAY-87	41	46	50	53
35	NB	DIS	10NB01BCFD01	700665	25-MAY-87	53	68	74	108
36	NS	DIS	00NS01DOFD10	701148	18-JUN-87	56	100	110	133
37	NS	NAT	00NS01DOFS10	701149	18-JUN-87	51	46	49	108
38	NS	NAT	00NS01DOFS10	701150	18-JUN-87	68	64	109	143
39	NF	DIS	00NF01YOFD22	701216	17-JUN-87	37	27	50	55
40	NF	NAT	00NF02YOFS22	701217	17-JUN-87	48	39	55	58
41	NF	NAT	00NF01YOFS22	701218	17-JUN-87	4	33	49	50
42	PE	DIS	10PE01CCFD56	702552	17-SEP-87	43	61	54	78
43	PE	DIS	10PE01CCFD56	702553	17-SEP-87	47	61	60	85
44	PE	DIS	10PE01CCFD56	702554	17-SEP-87				
45	NB	DIS	10NB01BCFD01	702786	05-OCT-87	46	57	54	78
46	NB	NAT	10NB01BCFS01	702787	05-OCT-87	48	61	60	98
47	NB	NAT	10NB01BCFS01	702788	05-OCT-87	50	68	70	95
48	NF	DIS	00NF01YOFD22	703060	22-OCT-87	55	64	66	85
49	NF	NAT	00NF01YOFS22	703061	22-OCT-87	48	57	59	85
50	NF	NAT	00NF01YOFS22	703062	22-OCT-87	80	93	90	120
51	NS	DIS	00NS01DOFD10	703139	29-OCT-87	37	43	56	80
52	NS	DIS	00NS01DOFD10	703140	29-OCT-87	43	50	39	105
53	NS	NAT	00NS01DOFS10	703142	29-OCT-87	44	54	49	75
54	PE	DIS	10PE01CCFD56	800623	19-MAY-88	62	75	98	103
55	PE	NAT	10PE01CCFS56	800624	19-MAY-88	31	39	51	56
56	PE	NAT	10PE01CCFS56	800625	19-MAY-88				

0	1 PROV	2 TYPE	3 STN	4 SAMPLE	5 SDATE	6 1,3-DCB	7 1,3,5-TCB	8 1,2,3,4-TeCB	9 HCB
57	NB	NAT	10NB01BUFS03	B00745	30-MAY-88	71	93	102	107
58	NB	NAT	10NB01BUFS03	B00746	30-MAY-88	72	95	103	109
59	NB	DIS	10NB01BUFD03	B00748	30-MAY-88	61	81	91	107
60	NS	DIS	01NS01EEFD52	B01074	15-JUN-88	73	83	110	110
61	NS	NAT	01NS01EEFS52	B01075	15-JUN-88	53	58	85	100
62	NS	NAT	01NS01EEFS52	B01076	15-JUN-88	79	88	103	113
63	NF	NAT	05NF02YEFS01	B01137	15-JUN-88	72	80	104	104
64	NF	NAT	05NF02YEFS01	B01138	15-JUN-88	73	76	90	95
65	NF	DIS	05NF02YEFD01	B01140	15-JUN-88	67	75	106	106
66	NB	DIS	10NB01BUFD03	B02061	19-SEP-88	63	80	90	95
67	NB	NAT	10NB01BUFS03	B02062	19-SEP-88	79	86	103	102
68	NB	NAT	10NB01BUFS03	B02063	19-SEP-88	88	95	122	112
69	PE	DIS	10PE01CBFD18	B02111	21-SEP-88	56	61	60	65
70	PE	NAT	10PE01CBFS18	B02112	21-SEP-88	58	69	63	68
71	PE	NAT	10PE01CBFS18	B02113	21-SEP-88	65	68	65	65
72	NS	DIS	01NS01EDFD62	B02598	19-OCT-88	77	102	101	97
73	NS	NAT	01NS01EDFS62	B02599	19-OCT-88	66	88	95	100
74	NS	NAT	01NS01EDFS62	B02600	19-OCT-88	72	85	88	88
75	NF	NAT	01NF02YAFS06	B02710	25-OCT-88	84	108	121	116
76	NF	NAT	01NF02YAFS06	B02711	25-OCT-88	62	77	110	99
77	NF	DIS	01NF02YAFD06	B02713	26-OCT-88	71	87	107	101
78									
79 MAXIMUM						88	108	122	143
80 MINIMUM						0	0	0	0
81 MEAN						55	65	75	90
82 MEDIAN						53	64	70	97
83 COUNT						73	73	73	55
84 STDEV						17	20	24	25

0	10 PP-DDT	11 OP-DDT	12 PP-DDD	13 PP-DDE	14 PP-MeCHLOR	15 HEPTACHLOR	16 HEP.EPOX.	17 a-ENDO.SUL.
1	200	134	134	140	91	180	156	107
2	220	146	122	160	110	180	148	107
3	220	150	136	153	110	172	172	100
4	120	92	100	64	70	90	51	77
5	64	48	50	120	60	64	40	38
6	116	84	100	181	140	112	104	180
7	104	88	72	107	126	96	152	77
8	77	69	68	70	100	73	64	77
9	120	52	44	173	110	112	88	77
10	88	88	100	240	110	96	88	77
11	70	60		60	75	50		67
12	71	63		60	80	50		67
13	120	99		69	131	50		66
14	52	63		49	83	29		43
15	226	129		90	164	80		66
16	228	129		89	169	80		78
17								
18	110	110		90	118	90		78
19	78	73		68	88	68		54
20	65	63		58	90	68		65
21	77	72		67	77	77		53
22	78	88		78	90	88		65
23	79	94		79	109	99		55
24	91	93		78	98	68		45
25	91	93		78	98	68		45
26	91	88		78	93	68		52
27	130	69		56	81	65		62
28	96	74		65	74	74		62
29	117	62		48	81	66		53
30	72			88	95	39		33
31	83			88	100	59		54
32	85			89	103	50		44
33	71			77	106	29		54
34	73			39	102	49		54
35	75			78	102	44		68
36	78			39	102	49		32
37	55			58	77	38		53
38	84			78	91	69		65
39	96			71	95	44		49
40								
41	83			55	80	37		41
42								
43								
44								
45	94			91	131	92		51
46	82			91	113	90		67
47	102			107	141	107		79
48	83			68	97	78		54
49	84			78	116	87		68
50	83			86	114	86		76
51								
52	78			68	110	78		65
53	87			69	116	67		63
54	103			87	123	135		109
55	99			96	122	144		89
56	96			86	120	134		89

0	10 PP-DDT	11 OP-DDT	12 PP-DDD	13 PP-DDE	14 PP-MeCHLOR	15 HEPTACHLOR	16 HEP.EPOX.	17 a-ENDO.SUL.
57	106			103	131	123		95
58	101			98	124	98		90
59	96			86	117	153		88
60	116			97	109	85		99
61	128			87	113	87		109
62	131			88	113	69		111
63	128			96	122	94		98
64	119			80	118	98		110
65	123			90	123	80		113
66	104			98	141	89		55
67	117			100	150	90		113
68	108			101	139	81		104
69	83			100	88	70		92
70	93			90	93	80		103
71	90			110	93	90		103
72	101			98	110	107		100
73	92			89	106	109		91
74	92			99	104	109		91
75	81			76	97	84		78
76	91			85	72	85		87
77	92			86	108	86		79
78								
79 MAXIMUM	228	150	136	240	169	180	172	180
80 MINIMUM	52	48	44	39	60	29	40	32
81 MEAN	102	88	93	89	106	84	106	75
82 MEDIAN	92	88	100	86	106	81	96	76
83 COUNT	71	28	10	71	71	71	10	71
84 STDEV	37	28	33	32	22	32	48	25

0	18 b-ENDO.SUL.	19 a-CHLOR.	20 g-CHLOR	21 g-BHC	22 a-BHC	23 MIREX	24 ALDRIN	25 ENDRIN
1	140	144	150	103	136	104	142	120
2	140	132	223	107	128	96	142	120
3	160	148	115	128	164	96	158	140
4	80	242	100	88	72	82	177	100
5	40	107	54	48	40	58	108	60
6	80	240	100	96	80	89	169	100
7	80	208	92	28	72	29	140	80
8	60	136	69	72	64	61	131	60
9	80	184	92	88	80	89	108	80
10	80	152	62	88	80	89	162	100
11	60	27	50	70	70	60		
12	55	27	50	50	70	60		
13	64	45	59	69	79	69		
14	44	39	49	29	59	42		
15	60	45	80	90	80	90		
16	65	45	80	100	80	100		
17								
18	80	55	90	90	120	83		
19	54	44	58	58	68	42		
20	54	35	58	58	78	88		
21	48	44	58	67	58	42		
22	54	44	68	88	68	58		
23	59	54	79	79	79	53		
24	54	44	78	78	78	75		
25	54	44	78	78	78	75		
26	64	53	87	78	97	52		
27	56	42	56	65	92	58		
28	60	42	74	65	74	71		
29	52	34	57	57	86	48		
30	93	53	78	59	59	78		
31	73	53	88	88	88	78		
32	73	45	89	79	79	79		
33	82	96	77	48	48	67		
34	78	89	88	68	88	68		
35	87	122	87	70	61	73		
36	39	79	87	78	78	65		
37	67	70	67	58	58	51		
38	78	89	69	78	88	46		
39	71	73	80	62	62	47		
40								
41	50	66	46	55	55	37		
42								
43								
44								
45	74	92	92	92	119	80		
46	76	89	83	91	83	83		
47	89	114	101	101	95	91		
48	63	71	68	58	58	71		
49	82	79	78	78	78	72		
50	82	86	77	77	77	72		
51								
52	73	62	68	78	68	49		
53	48	60	57	67	67	73		
54	92	85	97	106	106	100		
55	96	94	96	96	106	102		
56	91	84	96	96	96	90		

0		18 b-ENDO.SUL.	19 a-CHLOR.	20 g-CHLOR	21 g-BHC	22 a-BHC	23 MIREX	24 ALDRIN	25 ENDRIN
57		102	100	100	123	102	96		
58		98	104	97	97	97	91		
59		43	84	96	105	105	89		
60		92	94	97	87	97	100		
61		101	103	87	96	106	90		
62		98	105	88	98	108	95		
63		96	93	96	96	105	102		
64		102	96	89	89	89	98		
65		90	107	90	100	110	100		
66		45	122	107	89	107	92		
67		110	117	110	100	120	93		
68		96	118	111	101	121	88		
69		80	98	100	90	90	73		
70		80	98	100	90	100	83		
71		80	107	100	90	100	83		
72		107	114	98	107	117	98		
73		99	106	99	119	158	63		
74		94	116	99	119	149	63		
75		67	98	76	84	101	67		
76		72	100	85	94	111	68		
77		73	101	86	86	86	86		
78									
79	MAXIMUM	160	242	223	128	164	104	177	140
80	MINIMUM	39	27	46	28	40	29	108	60
81	MEAN	77	90	85	83	89	75	144	96
82	MEDIAN	78	89	87	88	86	78	142	100
83	COUNT	71	71	71	71	71	71	10	10
84	STDEV	23	45	25	20	25	19	24	26

0	26 DIELDRIN	27 T. PCB	28 Fl	29 B(b)Fl	30 B(k)Fl	31 B(a)Py	32 I(1,2,3,ccd)Pe	33 B(ghi)Pe
1	173	85	82	100	102	100	56	83
2	154	75	80	100	102	100	56	83
3	177	75	52	80	70	133	56	55
4	108	90	130	135	130	42	40	82
5	69	70	64	70	65	62	35	38
6	138	70	127	120	110	112	104	92
7	92	65	110	110	50	100	74	75
8	54	65	134	110	93	100	93	87
9	108	75	136	135	125	100	110	107
10	100	75	124	135	110	69	110	105
11			130	130	60	140		130
12			155	110	60	120		120
13			70	128	70	40		94
14			73	49	20	39		44
15			95	70	40	80		70
16			124	100	60	100		104
17								
18			165	120	60	120		115
19			78	117	78	117		127
20			68	98	39	78		98
21			77	135	77	116		96
22			88	137	78	98		98
23			89	108	79	158		158
24			107	88	39	78		83
25			107	88	39	78		83
26			100	68	39	58		58
27			125	74	37	56		83
28			125	83	56	92		92
29			109	66	38	57		66
30			93	88	39	98		93
31			63	78	39	78		93
32			94	89	40	79		99
33			39	87	39	77		87
34			39	59	20	59		59
35			96	87	35	87		91
36			73	78	39	97		78
37			58	58	38	58		62
38			83	69	39	59		74
39			80	107	53	142		133
40			50					
41			87	91	35	110		91
42			74	79	40	80		99
43			123	109	59	99		123
44			95	90	40	100		115
45				64	37	55		78
46			91	53	30	45		64
47			65	6	24	60		83
48			68	78	39	78		102
49			65	78	35	87		104
50			73	77	34	69		94
51								
52			24	10				
53			43	57	19	19		105
54			120					
55			125					
56			125					

0	26 DIELDRIN	27 T. PCB	28 F1	29 B(b)F1	30 B(k)F1	31 B(a)Py	32 I(1,2,3,ccd)Pe	33 B(ghi)Pe
57			115					
58			115					
59			110					
60			125					
61			115					
62			137					
63			125					
64			134					
65			110					
66			134					
67			140					
68			131					
69			100					
70			130					
71			100					
72			127					
73			119					
74			119					
75			126					
76			128					
77			120					
78								
79 MAXIMUM	177	90	165	137	130	158	110	158
80 MINIMUM	54	65	24	6	19	19	35	38
81 MEAN	117	75	100	89	55	85	73	91
82 MEDIAN	108	75	107	88	40	80	65	92
83 COUNT	10	10	74	50	49	49	10	49
84 STDEV	42	8	30	29	28	29	29	23

0	34 AZINPHOS ETHYL	35 AZINPHOS METHYL	36 DIAZINON	37 DISYSTON	38 ETHION	39 IMADAN	40 MALATHION	41 Me-PARATHION
1	100	120	96	92	88	29	88	80
2	92	108	96	38	84	28	88	76
3	60	52	84	76	108	34		52
4	52	52	150	52	76	31	48	72
5	64	68	40	27	68	37	28	64
6	90	30	52	64	96	11	48	108
7	76	90	132	56	100	50	104	124
8	56	88	80	56	92	31	64	104
9	116	68	80	64	104		72	104
10	100	68	90	68	112		100	100
11		165		110			170	
12		145	0	140			0	
13		200	128	89			128	
14		102	88	68			108	
15		104	119	100			0	
16		0	109	109			0	
17								
18		105	120	20			90	
19		78	200	10			160	
20			98	98			98	
21		140	154	183			125	
22		145	140	183			125	
23		153	158	207			0	
24								
25		100	120	100			100	
26								
27		153	139	213			102	
28		148	148	157			102	
29		142	133	190			95	
30		59		59			166	
31		63		49			165	
32		69		50			168	
33		14		39			116	
34		29		68			137	
35		52		44			157	
36		49		49			58	
37		67		19			125	
38		69		20			137	
39		44		18			133	
40								
41		59		18			137	
42		94		60			30	
43		94		69			40	
44		55		100			20	
45		41		46			110	
46				61			98	
47		39		71			113	
48		15		19			117	
49		30		69			148	
50		56		69			137	
51								
52		20		20			50	
53		18		10			19	
54		121		106			102	
55		130		119			114	
56		120		104			94	

0	34 AZINPHOS ETHYL	35 AZINPHOS METHYL	36 DIAZINON	37 DISYSTON	38 ETHION	39 IMADAN	40 MALATHION	41 Me-PARATHION
57		15		72			113	
58		15		68			98	
59		14		48			67	
60		82		19			87	
61		91		67			96	
62		78		78			78	
63		96		105			96	
64		53		45			36	
65		115		90			100	
66		81		55			40	
67		115		0			98	
68		66		0			99	
69		85		7			68	
70		100		5			66	
71		110		5			69	
72		102		50			84	
73		139		25			92	
74		134		29			88	
75		92		49			64	
76		85		79			72	
77		86		71			79	
78								
79 MAXIMUM	116	200	200	213	112	50	170	124
80 MINIMUM	52	0	0	0	68	11	0	52
81 MEAN	81	83	110	68	93	31	90	88
82 MEDIAN	83	84	119	63	94	31	96	90
83 COUNT	10	70	25	72	10	8	71	10
84 STDEV	22	43	42	49	14	11	42	23

0	42 PARATHION	43 PHORATE	44 RONNEL	45 2,6-DCP	46 2,5-DCP	47 2,4-DCP	48 3,5-DCP	49 2,3-DCP
1	104	88	96	83	87	87	93	83
2	110	88	96	113	172	117	130	137
3	124	104	120	50	43	43	57	100
4	96	60	96	77	107	107	140	120
5	92	44	88	83	103	103	130	103
6		84	108	107	84	90	113	113
7		100	124	110	97	97	127	87
8		80	96	90	77	77	107	87
9	100	88	89	93	77	77	117	93
10	100	88	92	100	87	87	120	103
11		100		67		87		
12		40		67		87		
13		89		123		123		
14		78		107		107		
15		0		117		147		
16		0		117		140		
17				133		153		
18		70		127		137		
19		100		120		150		
20		98		123		147		
21		96		93		93		
22		90		80		83		
23		99		77		83		
24				120		113		
25		50		120		113		
26				120		110		
27		92		87		83		
28		83		73		70		
29		86		80		77		
30		78		110		93		
31		68						
32		69						
33		39		103		113		
34		59		100		117		
35		52		117		140		
36		39		90		87		
37		29		80		70		
38		49		90		87		
39		36		80		90		
40				67		57		
41		46		73		63		
42		89		110		93		
43		99				117		
44		90		93		130		
45		46		73		103		
46		53		70		110		
47		60		63		107		
48		29		80		107		
49		78		73		107		
50		77		87		113		
51				90		130		
52		20		33		43		
53		10		80		110		
54		98		100		130		
55		108		63		87		
56		90		93		120		

	42 PARATHION	43 PHORATE	44 RONNEL	45 2,6-DCP	46 2,5-DCP	47 2,4-DCP	48 3,5-DCP	49 2,3-DCP
57		51		93		120		
58		49		97		127		
59		77		87		113		
60		68		0		0		
61		67		80		93		
62		59		0		0		
63		67						
64		45						
65		60		63		77		
66		81		87		93		
67		43		100		93		
68		21		90		100		
69		68		0		0		
70		53		47		53		
71		50		60		57		
72		83		90		90		
73		82		50		53		
74		83		67		67		
75		73		50		47		
76		94		60		53		
77		82		80		83		
78								
79 MAXIMUM	124	108	124	133	172	153	140	137
80 MINIMUM	92	0	88	0	43	0	57	83
81 MEAN	104	68	101	84	93	94	113	103
82 MEDIAN	100	72	96	87	87	93	119	102
83 COUNT	7	72	10	72	10	73	10	10
84 STDEV	11	26	13	28	33	33	24	17

0	50 3,4-DCP	51 2,4,6-TCP	52 2,3,6-TCP	53 2,3,5-TCP	54 3,4,5-TCP	55 2,3,5,6-TeCP	56 2,3,4,5-TeCP
1	76	67	77	87	87	67	83
2	83	97	103	120	120	89	117
3	43	40	40	47	50	39	50
4	87	127	100	107	117	94	88
5	87	107	113	110	107	94	89
6	90	87	93	93	97	82	95
7	87	97	100	107	110	83	117
8	83	70	85	83	87	67	78
9	67	77	87	93	93	92	94
10	80	87	93	103	103	88	100
11		37		80		61	72
12		40		103		78	94
13		103		100		133	100
14		100		83		111	78
15		103		113		94	140
16		107		117		89	122
17		120		113		106	139
18		107		110		89	106
19		120		160		0	140
20		93		143		86	86
21		93		87		100	94
22		77		70		89	89
23		73		67		89	89
24		117		110		117	117
25		117		110		117	117
26		117		110		117	117
27		87		77		72	78
28		70		63		89	67
29		80		73		72	83
30		103		103		106	106
31							
32							
33		110		110		117	106
34		110		110		111	106
35		127		130		133	122
36		97		93		94	89
37		93		93		100	94
38		93		93		89	89
39		83		83		89	89
40		67		63		61	61
41		73		73		67	67
42		130		130		128	128
43		87		87		78	89
44		93		100		100	100
45		83		83		78	83
46		87		90		83	89
47		83		83		78	88
48		77		77		67	72
49		77		73		67	67
50		87		80		67	67
51		103		110		100	100
52		33		33		34	34
53		90		90		78	78
54		103		100		100	100
55		70		67		72	72
56		90		90		94	89

0	50 3,4-DCP	51 2,4,6-TCP	52 2,3,6-TCP	53 2,3,5-TCP	54 3,4,5-TCP	55 2,3,5,6-TeCP	56 2,3,4,5-TeCP
57		93		93		83	94
58		97		100		94	94
59		83		83		89	83
60		0		0		0	0
61		80		90		72	89
62		0		0		0	0
63							
64							
65		93		73		100	78
66		93		87		89	89
67		90		87		89	89
68		110		90		89	94
69		0		0		0	0
70		43		40		41	39
71		57		53		56	56
72		83		80		83	78
73		37		33		35	22
74		43		40		33	24
75		57		25		24	49
76		63		28		33	61
77		83		73		83	78
78							
79 MAXIMUM	90	130	113	160	120	133	140
80 MINIMUM	43	0	40	0	50	0	0
81 MEAN	78	83	89	84	97	79	84
82 MEDIAN	83	87	93	87	100	88	89
83 COUNT	10	73	10	73	10	73	73
84 STDEV	14	28	20	31	20	30	30

0	57 PCP	58 CARBARYL	59 ALDICARB	60 ALD. SULFOX.	61 ALD. SULFONE	62 CARBOFURAN
1	83	55				
2	106	50				
3	50	68				
4	106	100				
5	100	100				
6	100	93				
7	138	93				
8	83	79				
9	117	100				
10	117	100				
11	83	102				
12	94	102				
13	150	105				
14	128	102				
15	133	100				
16	122	100				
17	128	112				
18	106	102				
19	160	100				
20	86	76				
21	100	94	64	80	86	
22	89	108	76	88	96	
23	89	94	70	80	98	
24	117	98	74	92	70	
25	117	98	75	92	70	
26	117	110	76	110	78	
27	78	110	72	81	83	
28	67	120	79	83	80	
29	78	120	76	82	85	
30	100					
31						
32						
33	117					
34	106					
35	122					
36	89					
37	89					
38	89					
39	89					
40	61					
41	67					
42	128					
43	89					
44	100					
45	72					
46	78					
47	72					
48	72					
49	67					
50	67					
51	100					
52	38					
53	83					
54	94	100	100	25	100	
55	67	100	75	25	100	
56	83	100	100	25	100	

0		57 PCP	58 CARBARYL	59 ALDICARB	60 ALD. SULFOX.	61 ALD. SULFONE	62 CARBOFURAN
57		78	100	100	25	100	
58		89	100	50	50	100	
59		78	125	100	25	100	
60		0	75	100	75	75	
61		83					
62		0	75	100	25	100	
63			50	75	25	75	
64			50	100	25	75	
65		100	50	75	25	75	
66		78	108	98	28	115	108
67		78	43	0	85	98	83
68		83	88	0	90	108	100
69		0	0	73	15	30	23
70		43	52	0	65	65	65
71		56	58	0	70	70	78
72		72	0	88	0	0	0
73		38	118	85	28	105	103
74		45	125	88	23	103	105
75		48	25	95	18	83	78
76		61	30	105	25	88	75
77		78	100	95	18	110	100
78							
79	MAXIMUM	160	125	105	110	115	108
80	MINIMUM	0	0	0	0	0	0
81	MEAN	86	86	74	50	85	77
82	MEDIAN	86	100	76	28	87	81
83	COUNT	73	52	32	32	32	12
84	STDEV	31	30	31	32	23	34

APPENDIX B

Municipal drinking water survey, quality control organic spikes:
yearly statistics.

0			1 1,3-DCB	2 1,3,5-TCB	3 1,2,3,4-TeCB	4 HCB	5 PP-DDT	6 OP-DDT	7 PP-DDD	8 PP-DDE
1										
2										
3										
4	MAXIMUM	1985	73	50	105		220	150	136	240
5	MINIMUM		47	42	31		64	48	44	64
6	MEAN		54	46	65		133	95	93	141
7	MEDIAN		50	46	63		118	88	100	147
8	COUNT		10	10	10	0	10	10	10	10
9	STDEV		8	3	25		59	37	33	53
10										
11										
12										
13	MAXIMUM	1986	78	104	115	103	228	129		90
14	MINIMUM		20	43	50	50	52	60		48
15	MEAN		50	66	75	77	104	85		70
16	MEDIAN		48	64	71	73	91	81		69
17	COUNT		16	16	16	8	18	18	0	18
18	STDEV		17	17	17	20	49	22		13
19										
20										
21										
22	MAXIMUM	1987	80	100	110	143	102			107
23	MINIMUM		4	27	39	50	55			39
24	MEAN		48	60	64	91	82			75
25	MEDIAN		48	61	60	88	83			78
26	COUNT		23	23	23	23	19	0	0	19
27	STDEV		13	17	18	25	10			18
28										
29										
30										
31	MAXIMUM	1988	88	108	122	116	131			110
32	MINIMUM		31	39	51	56	81			76
33	MEAN		68	80	94	96	104			93
34	MEDIAN		71	81	101	101	101			93
35	COUNT		23	23	23	23	24	0	0	24
36	STDEV		12	15	19	17	15			8

0	9 PP-MeCHLOR	10 HEPTACHLOR	11 HEP.EPOX.	12 a-ENDO.SUL.	13 b-ENDO.SUL.	14 a-CHLOR.
1						
2						
3						
4 MAXIMUM 1985	140	180	172	180	160	242
5 MINIMUM	60	64	40	38	40	107
6 MEAN	103	118	106	92	94	169
7 MEDIAN	110	104	96	77	80	150
8 COUNT	10	10	10	10	10	10
9 STDEV	24	44	48	37	39	47
10						
11						
12						
13 MAXIMUM 1986	169	99		78	80	55
14 MINIMUM	74	29		43	44	27
15 MEAN	100	69		60	58	42
16 MEDIAN	90	68		62	56	44
17 COUNT	18	18	0	18	18	18
18 STDEV	29	17		10	8	8
19						
20						
21						
22 MAXIMUM 1987	141	107		79	93	122
23 MINIMUM	77	29		32	39	45
24 MEAN	105	63		56	73	78
25 MEDIAN	102	59		54	74	79
26 COUNT	19	19	0	19	19	19
27 STDEV	15	23		13	14	20
28						
29						
30						
31 MAXIMUM 1988	150	153		113	110	122
32 MINIMUM	72	69		55	43	84
33 MEAN	114	99		96	88	102
34 MEDIAN	115	90		97	93	101
35 COUNT	24	24	0	24	24	24
36 STDEV	18	23		13	17	11

0			15 g-CHLOR	16 g-BHC	17 a-BHC	18 MIREX	19 ALDRIN	20 ENDRIN	21 DIELDRIN	22 T. PCB	23 F1
1											
2											
3											
4	MAXIMUM	1985	223	128	164	104	177	140	177	90	136
5	MINIMUM		54	28	40	29	108	60	54	65	52
6	MEAN		106	85	92	79	144	96	117	75	104
7	MEDIAN		96	88	80	89	142	100	108	75	117
8	COUNT		10	10	10	10	10	10	10	10	10
9	STDEV		50	29	38	23	24	26	42	8	31
10											
11											
12											
13	MAXIMUM	1986	90	100	120	100					165
14	MINIMUM		49	29	58	42					68
15	MEAN		67	71	79	65					105
16	MEDIAN		64	70	78	60					104
17	COUNT		18	18	18	18	0	0	0	0	18
18	STDEV		14	17	14	18					28
19											
20											
21											
22	MAXIMUM	1987	101	101	119	91					123
23	MINIMUM		46	48	48	37					24
24	MEAN		78	73	74	67					72
25	MEDIAN		78	77	77	72					73
26	COUNT		19	19	19	19	0	0	0	0	22
27	STDEV		13	14	17	15					24
28											
29											
30											
31	MAXIMUM	1988	111	123	158	102					140
32	MINIMUM		76	84	86	63					100
33	MEAN		96	98	108	88					122
34	MEDIAN		97	96	106	91					125
35	COUNT		24	24	24	24	0	0	0	0	24
36	STDEV		8	11	17	12					10

0		24 B(b)Fl	25 B(k)Fl	26 B(a)Py	27 I(1,2,3,ccd)Pe	28 B(ghi)Pe	29 AZINPHOS ETHYL	30 AZINPHOS METHYL
1								
2								
3								
4	MAXIMUM 1985	135	130	133	110	107	116	120
5	MINIMUM	70	50	42	35	38	52	30
6	MEAN	110	96	92	73	81	81	74
7	MEDIAN	110	102	100	65	83	83	68
8	COUNT	10	10	10	10	10	10	10
9	STDEV	23	26	27	29	21	22	27
10								
11								
12								
13	MAXIMUM 1986	137	79	158		158		200
14	MINIMUM	49	20	39		44		0
15	MEAN	98	54	90		96		125
16	MEDIAN	99	58	86		95		142
17	COUNT	18	18	18	0	18	0	15
18	STDEV	27	18	34		28		47
19								
20								
21								
22	MAXIMUM 1987	109	59	142		133		94
23	MINIMUM	6	19	19		59		14
24	MEAN	72	38	78		92		49
25	MEDIAN	78	39	78		93		52
26	COUNT	22	21	21	0	21	0	21
27	STDEV	26	10	26		19		23
28								
29								
30								
31	MAXIMUM 1988							139
32	MINIMUM							14
33	MEAN							89
34	MEDIAN							92
35	COUNT	0	0	0	0	0	0	24
36	STDEV							36

0			31 DIAZINON	32 DISYSTON	33 ETHION	34 IMADAN	35 MALATHION	36 Me-PARATHION	37 PARATHION
1									
2									
3									
4	MAXIMUM	1985	150	92	112	50	104	124	124
5	MINIMUM		40	27	68	11	28	52	92
6	MEAN		90	59	93	31	71	88	104
7	MEDIAN		87	60	94	31	72	90	100
8	COUNT		10	10	10	8	9	10	7
9	STDEV		33	18	14	11	26	23	11
10									
11									
12									
13	MAXIMUM	1986	200	213			170		
14	MINIMUM		0	10			0		
15	MEAN		124	124			88		
16	MEDIAN		128	110			101		
17	COUNT		15	16	0	0	16	0	0
18	STDEV		44	62			57		
19									
20									
21									
22	MAXIMUM	1987		100			168		
23	MINIMUM			10			19		
24	MEAN			47			108		
25	MEDIAN			49			121		
26	COUNT		0	22	0	0	22	0	0
27	STDEV			24			49		
28									
29									
30									
31	MAXIMUM	1988		119			114		
32	MINIMUM			0			36		
33	MEAN			54			83		
34	MEDIAN			53			88		
35	COUNT		0	24	0	0	24	0	0
36	STDEV			37			20		

0		38 PHORATE	39 RONNEL	40 2,6-DCP	41 2,5-DCP	42 2,4-DCP	43 3,5-DCP	44 2,3-DCP	45 3,4-DCP
1									
2									
3									
4	MAXIMUM 1985	104	124	113	172	117	140	137	90
5	MINIMUM	44	88	50	43	43	57	83	43
6	MEAN	82	101	91	93	89	113	103	78
7	MEDIAN	88	96	92	87	89	119	102	83
8	COUNT	10	10	10	10	10	10	10	10
9	STDEV	18	13	19	33	20	24	17	14
10									
11									
12									
13	MAXIMUM 1986	100		133		153			
14	MINIMUM	0		67		70			
15	MEAN	73		103		111			
16	MEDIAN	88		117		110			
17	COUNT	16	0	19	0	19	0	0	0
18	STDEV	33		23		28			
19									
20									
21									
22	MAXIMUM 1987	99		117		140			
23	MINIMUM	10		33		43			
24	MEAN	55		84		99			
25	MEDIAN	53		80		107			
26	COUNT	22	0	21	0	22	0	0	0
27	STDEV	24		19		24			
28									
29									
30									
31	MAXIMUM 1988	108		100		130			
32	MINIMUM	21		47		47			
33	MEAN	69		77		87			
34	MEDIAN	68		80		90			
35	COUNT	24	0	19	0	19	0	0	0
36	STDEV	20		18		27			

0		46 2,4,6-TCP	47 2,3,6-TCP	48 2,3,5-TCP	49 3,4,5-TCP	50 2,3,5,6-TeCP	51 2,3,4,5-TeCP	52 PCP
1								
2								
3								
4 MAXIMUM	1985	127	113	120	120	94	117	138
5 MINIMUM		40	40	47	50	39	50	50
6 MEAN		86	89	95	97	80	91	100
7 MEDIAN		87	93	98	100	86	92	103
8 COUNT		10	10	10	10	10	10	10
9 STDEV		24	20	20	20	17	19	24
10								
11								
12								
13 MAXIMUM	1986	120		160		133	140	160
14 MINIMUM		37		63		0	67	67
15 MEAN		93		99		90	101	107
16 MEDIAN		100		103		89	94	106
17 COUNT		19	0	19	0	19	19	19
18 STDEV		25		26		28	23	26
19								
20								
21								
22 MAXIMUM	1987	130		130		133	128	128
23 MINIMUM		33		33		34	34	38
24 MEAN		90		90		88	87	86
25 MEDIAN		89		90		86	89	89
26 COUNT		22	0	22	0	22	22	22
27 STDEV		20		21		24	21	22
28								
29								
30								
31 MAXIMUM	1988	110		100		100	100	100
32 MINIMUM		37		25		24	22	38
33 MEAN		77		70		72	73	71
34 MEDIAN		83		80		83	78	78
35 COUNT		19	0	19	0	19	19	19
36 STDEV		22		25		26	24	18

0			53 CARBARYL	54 ALDICARB	55 ALD. SULFOX.	56 ALD. SULFONE	57 CARBOFURAN
1							
2							
3							
4	MAXIMUM	1985	100				
5	MINIMUM		50				
6	MEAN		84				
7	MEDIAN		93				
8	COUNT		10	0	0	0	0
9	STDEV		20				
10							
11							
12							
13	MAXIMUM	1986	120	79	110	98	
14	MINIMUM		76	64	80	70	
15	MEAN		103	74	88	83	
16	MEDIAN		102	75	83	83	
17	COUNT		19	9	9	9	0
18	STDEV		10	4	10	10	
19							
20							
21							
22	MAXIMUM	1987					
23	MINIMUM						
24	MEAN						
25	MEDIAN						
26	COUNT		0	0	0	0	0
27	STDEV						
28							
29							
30							
31	MAXIMUM	1988	125	105	90	115	108
32	MINIMUM		0	0	0	0	0
33	MEAN		73	74	35	86	77
34	MEDIAN		75	88	25	100	81
35	COUNT		23	23	23	23	12
36	STDEV		38	37	24	27	34

APPENDIX C

Municipal drinking water survey, quality control organic spikes:
provincial statistics.

0		1 1,3-DCB	2 1,3,5-TCB	3 1,2,3,4-TeCB	4 HCB	5 PP-DDT	6 OP-DDT	7 PP-DDD	8 PP-DDE
1									
2	MAXIMUM NB	88	95	122	112	228	129		107
3	MINIMUM	40	43	50	53	71	88		39
4	MEAN	59	68	81	98	107	104		87
5	MEDIAN	55	66	81	103	95	94		90
6	COUNT	18	18	18	14	18	6	0	18
7	STDEV	14	17	19	16	45	19		16
8									
9									
10									
11	MAXIMUM NS	79	104	110	143	131	99		99
12	MINIMUM	37	43	39	75	52	63		39
13	MEAN	58	74	81	102	91	81		76
14	MEDIAN	56	82	85	100	87	80		78
15	COUNT	15	15	15	14	15	4	0	15
16	STDEV	14	21	24	20	24	16		18
17									
18									
19									
20	MAXIMUM PEI	78	89	115	106	103	73		110
21	MINIMUM	31	39	51	56	65	60		58
22	MEAN	55	68	72	82	84	65		83
23	MEDIAN	54	69	64	82	83	63		88
24	COUNT	12	12	12	10	13	4	0	13
25	STDEV	13	12	20	18	12	6		16
26									
27									
28									
29	MAXIMUM NF	84	108	121	120	130	110		96
30	MINIMUM	4	27	49	50	81	62		48
31	MEAN	51	67	77	82	101	79		75
32	MEDIAN	48	71	66	85	96	72		78
33	COUNT	17	17	17	16	15	4	0	15
34	STDEV	23	22	25	25	18	21		14

0		9 PP-MeCHLOR	10 HEPTACHLOR	11 HEP.EPOX.	12 a-ENDO.SUL.	13 b-ENDO.SUL.	14 a-CHLOR.	15 g-CHLOR
1								
2	MAXIMUM NB	169	153		113	110	122	111
3	MINIMUM	93	29		45	43	44	77
4	MEAN	124	84		70	74	85	91
5	MEDIAN	121	85		67	75	91	88
6	COUNT	18	18	0	18	18	18	18
7	STDEV	23	29		21	20	30	12
8								
9								
10								
11	MAXIMUM NS	131	109		111	107	116	99
12	MINIMUM	77	29		32	39	39	49
13	MEAN	102	74		74	74	78	77
14	MEDIAN	106	77		65	73	79	69
15	COUNT	15	15	0	15	15	15	15
16	STDEV	15	25		25	24	28	18
17								
18								
19								
20	MAXIMUM PEI	123	144		109	96	107	100
21	MINIMUM	75	39		33	54	27	50
22	MEAN	98	80		75	75	65	82
23	MEDIAN	93	68		67	80	53	89
24	COUNT	13	13	0	13	13	13	13
25	STDEV	16	36		25	16	30	20
26								
27								
28								
29	MAXIMUM NF	123	98		113	102	107	96
30	MINIMUM	72	37		41	50	34	46
31	MEAN	100	77		74	73	76	77
32	MEDIAN	97	84		76	72	79	78
33	COUNT	15	15	0	15	15	15	15
34	STDEV	19	17		22	16	24	14

0		16 g-BHC	17 a-BHC	18 MIREX	19 ALDRIN	20 ENDRIN	21 DIELDRIN	22 T. PCB	23 F1	24 B(b)F1
1										
2	MAXIMUM NB	123	121	100					140	108
3	MINIMUM	48	48	52					39	6
4	MEAN	88	91	81					100	73
5	MEDIAN	91	92	86					107	79
6	COUNT	18	18	18	0	0	0	0	17	12
7	STDEV	17	20	14					29	27
8										
9										
10										
11	MAXIMUM NS	119	158	100					137	137
12	MINIMUM	29	58	42					24	10
13	MEAN	83	91	67					89	80
14	MEDIAN	78	79	63					83	69
15	COUNT	15	15	15	0	0	0	0	15	9
16	STDEV	24	32	20					34	44
17										
18										
19										
20	MAXIMUM PEI	106	106	102					155	130
21	MINIMUM	50	59	42					63	78
22	MEAN	79	85	78					105	99
23	MEDIAN	88	88	79					100	94
24	COUNT	13	13	13	0	0	0	0	16	10
25	STDEV	18	16	17					26	17
26										
27										
28										
29	MAXIMUM NF	100	120	102					165	120
30	MINIMUM	55	55	37					50	66
31	MEAN	77	87	72					106	86
32	MEDIAN	78	86	71					115	78
33	COUNT	15	15	15	0	0	0	0	16	9
34	STDEV	16	20	20					31	17

0		25 B(k)Fl	26 B(a)Py	27 I(1,2,3,cd)Pe	28 B(ghi)Pe	29 AZINPHOS ETHYL	30 AZINPHOS METHYL	31 DIAZINON
1								
2	MAXIMUM NB	79	158		158		153	
3	MINIMUM	20	45		58		0	
4	MEAN	40	78		85		56	
5	MEDIAN	39	78		83		41	
6	COUNT	12	12	0	12	0	15	
7	STDEV	16	30		27		46	
8								
9								
10								
11	MAXIMUM NS	78	116		105		200	
12	MINIMUM	19	19		44		18	
13	MEAN	48	66		81		96	
14	MEDIAN	39	59		86		91	
15	COUNT	8	8	0	8	0	15	
16	STDEV	24	34		21		50	
17								
18								
19								
20	MAXIMUM PEI	78	140		130		165	
21	MINIMUM	39	78		93		55	
22	MEAN	49	99		110		99	
23	MEDIAN	40	99		107		94	
24	COUNT	10	10	0	10	0	15	
25	STDEV	14	21		15		33	
26								
27								
28								
29	MAXIMUM NF	60	142		133		153	
30	MINIMUM	34	56		66		15	
31	MEAN	45	90		98		85	
32	MEDIAN	39	87		94		86	
33	COUNT	9	9	0	9	0	15	
34	STDEV	10	29		19		43	

0		32 DISYSTON	33 ETHION	34 INADAN	35 MALATHION	36 Me-PARATHION	37 PARATHION	38 PHORATE
1								
2	MAXIMUM NB	207			157			99
3	MINIMUM	0			0			0
4	MEAN	68			84			49
5	MEDIAN	65			99			51
6	COUNT	16	0	0	16	0	0	16
7	STDEV	48			49			26
8								
9								
10								
11	MAXIMUM NS	183			137			96
12	MINIMUM	10			19			10
13	MEAN	61			93			63
14	MEDIAN	49			92			68
15	COUNT	15	0	0	15	0	0	15
16	STDEV	55			33			27
17								
18								
19								
20	MAXIMUM PEI	140			170			108
21	MINIMUM	5			0			40
22	MEAN	68			96			81
23	MEDIAN	65			96			90
24	COUNT	16	0	0	16	0	0	16
25	STDEV	45			58			21
26								
27								
28								
29	MAXIMUM NF	213			148			94
30	MINIMUM	18			36			29
31	MEAN	81			101			68
32	MEDIAN	69			100			73
33	COUNT	15	0	0	15	0	0	15
34	STDEV	62			31			20

0		39 RONNEL	40 2,6-DCP	41 2,5-DCP	42 2,4-DCP	43 3,5-DCP	44 2,3-DCP	45 3,4-DCP	46 2,4,6-TCP
1									
2	MAXIMUM NB		120		147				127
3	MINIMUM		63		83				73
4	MEAN		97		113				100
5	MEDIAN		99		113				100
6	COUNT	0	18	0	18	0	0	0	18
7	STDEV		19		17				15
8									
9									
10									
11	MAXIMUM NS		123		130				103
12	MINIMUM		33		43				33
13	MEAN		82		88				80
14	MEDIAN		85		89				92
15	COUNT	0	14	0	14	0	0	0	14
16	STDEV		22		25				24
17									
18									
19									
20	MAXIMUM PEI		123		150				130
21	MINIMUM		47		53				37
22	MEAN		88		104				82
23	MEDIAN		93		93				90
24	COUNT	0	12	0	13	0	0	0	13
25	STDEV		26		31				30
26									
27									
28									
29	MAXIMUM NF		133		153				120
30	MINIMUM		50		47				57
31	MEAN		81		88				82
32	MEDIAN		80		83				80
33	COUNT	0	15	0	15	0	0	0	15
34	STDEV		22		31				16

0		47 2,3,6-TCP	48 2,3,5-TCP	49 3,4,5-TCP	50 2,3,5,6-TeCP	51 2,3,4,5-TeCP	52 PCP	53 CARBARYL
1								
2	MAXIMUM NB		130		133	140	133	125
3	MINIMUM		67		78	83	72	43
4	MEAN		99		98	102	97	97
5	MEDIAN		97		89	94	89	100
6	COUNT	0	18	0	18	18	18	12
7	STDEV		16		16	17	21	19
8								
9								
10								
11	MAXIMUM NS		110		133	100	150	125
12	MINIMUM		33		33	22	38	0
13	MEAN		78		82	76	85	89
14	MEDIAN		89		89	89	89	102
15	COUNT	0	14	0	14	14	14	9
16	STDEV		25		30	28	31	38
17								
18								
19								
20	MAXIMUM PEI		160		128	140	160	102
21	MINIMUM		40		0	39	43	0
22	MEAN		97		77	90	91	79
23	MEDIAN		100		78	89	89	100
24	COUNT	0	13	0	13	13	13	10
25	STDEV		34		33	27	30	34
26								
27								
28								
29	MAXIMUM NF		113		106	139	128	120
30	MINIMUM		25		24	49	48	25
31	MEAN		72		72	77	78	79
32	MEDIAN		73		72	72	72	100
33	COUNT	0	15	0	15	15	15	11
34	STDEV		23		22	22	21	38

0		54 ALDICARB	55 ALD. SULFOX.	56 ALD. SULFONE	57 CARBOFURAN
1					
2	MAXIMUM NB	100	110	115	108
3	MINIMUM	0	25	70	83
4	MEAN	64	68	94	97
5	MEDIAN	75	83	99	100
6	COUNT	10	10	10	3
7	STDEV	37	32	16	13
8					
9					
10					
11	MAXIMUM NS	100	88	105	105
12	MINIMUM	64	0	0	0
13	MEAN	86	46	81	69
14	MEDIAN	88	28	96	103
15	COUNT	7	7	7	3
16	STDEV	13	35	37	60
17					
18					
19					
20	MAXIMUM PEI	100	70	100	78
21	MINIMUM	0	15	30	23
22	MEAN	58	38	78	55
23	MEDIAN	74	25	85	65
24	COUNT	6	6	6	3
25	STDEV	46	24	28	29
26					
27					
28					
29	MAXIMUM NF	105	83	110	100
30	MINIMUM	72	18	75	75
31	MEAN	86	42	84	84
32	MEDIAN	79	25	83	78
33	COUNT	9	9	9	3
34	STDEV	13	30	11	14

APPENDIX D

Municipal drinking water survey, quality control organic spikes:
statistics for water types.

0		1 1,3-DCB	2 1,3,5-TCB	3 1,2,3,4-TeCB	4 HCB	5 PP-DDT	6 OP-DDT	7 PP-DDD	8 PP-DDE
1									
2	MAXIMUM DIST	77	102	110	133	123			100
3	MINIMUM	37	27	39	55	72			39
4	MEAN	55	69	77	94	92			83
5	MEDIAN	55	68	73	97	93			88
6	COUNT	19	19	19	19	16	0	0	16
7	STDEV	12	18	23	18	15			16
8									
9									
10									
11	MAXIMUM GRND	88	95	122	112	117			110
12	MINIMUM	31	39	50	53	71			39
13	MEAN	59	72	78	90	94			91
14	MEDIAN	56	70	70	100	96			96
15	COUNT	12	12	12	12	13	0	0	13
16	STDEV	17	18	24	23	14			18
17									
18									
19									
20	MAXIMUM SURF	84	108	121	143	131			99
21	MINIMUM	4	33	49	50	55			55
22	MEAN	60	70	84	97	96			80
23	MEDIAN	66	76	90	100	89			83
24	COUNT	15	15	15	15	14	0	0	14
25	STDEV	20	22	25	24	22			13

0		9 PP-MeCHLOR	10 HEPTACHLOR	11 HEP.EPOX.	12 a-ENDO.SUL.	13 b-ENDO.SUL.	14 a-CHLOR.
1							
2	MAXIMUM DIST	141	153		113	107	122
3	MINIMUM	88	39		32	39	53
4	MEAN	109	81		71	75	88
5	MEDIAN	109	79		67	74	89
6	COUNT	16	16	0	16	16	16
7	STDEV	14	32		26	20	22
8							
9							
10							
11	MAXIMUM GRND	150	144		113	110	118
12	MINIMUM	93	29		44	73	45
13	MEAN	118	90		83	89	97
14	MEDIAN	120	90		89	89	98
15	COUNT	13	13	0	13	13	13
16	STDEV	19	34		22	11	19
17							
18							
19							
20	MAXIMUM SURF	122	109		111	102	116
21	MINIMUM	72	37		41	48	60
22	MEAN	103	80		82	81	91
23	MEDIAN	110	86		83	82	95
24	COUNT	14	14	0	14	14	14
25	STDEV	17	22		22	18	17

0		15 g-CHLOR	16 g-BHC	17 a-BHC	18 MIREX	19 ALDRIN	20 ENDRIN	21 DIELDRIN	22 T. PCB	23 F1
1										
2	MAXIMUM DIST	107	107	119	100					134
3	MINIMUM	68	58	58	47					24
4	MEAN	89	85	88	80					96
5	MEDIAN	89	88	89	79					98
6	COUNT	16	16	16	16	0	0	0	0	18
7	STDEV	11	16	22	17					29
8										
9										
10										
11	MAXIMUM GRND	111	123	121	102					140
12	MINIMUM	77	48	48	67					39
13	MEAN	96	91	95	86					101
14	MEDIAN	97	96	97	88					115
15	COUNT	13	13	13	13	0	0	0	0	13
16	STDEV	10	18	19	10					34
17										
18										
19										
20	MAXIMUM SURF	99	119	158	102					137
21	MINIMUM	46	35	35	37					43
22	MEAN	80	86	96	71					97
23	MEDIAN	82	87	95	70					115
24	COUNT	14	14	14	14	0	0	0	0	15
25	STDEV	16	19	30	20					33

0		24 B(b)Fl	25 B(k)Fl	26 B(a)Py	27 I(1,2,3,ccd)Pe	28 B(ghi)Pe	29 AZINPHOS ETHYL	30 AZINPHOS METHYL
1								
2	MAXIMUM DIST	109	59	142		133		121
3	MINIMUM	10	35	55		78		14
4	MEAN	79	42	91		101		67
5	MEDIAN	79	39	92		96		63
6	COUNT	11	10	10	0	10	0	19
7	STDEV	26	8	23		18		32
8								
9								
10								
11	MAXIMUM GRND	89	40	79		99		130
12	MINIMUM	6	20	45		59		14
13	MEAN	59	31	64		78		69
14	MEDIAN	59	30	60		83		68
15	COUNT	5	5	5	0	5	0	12
16	STDEV	34	9	14		17		45
17								
18								
19								
20	MAXIMUM SURF	91	55	110		105		139
21	MINIMUM	57	19	19		62		18
22	MEAN	72	37	67		88		76
23	MEDIAN	73	37	64		93		74
24	COUNT	6	6	6	0	6	0	14
25	STDEV	13	12	31		17		34

0	31 DIAZINON	32 DISYSTON	33 ETHION	34 IMADAN	35 MALATHION	36 Me-PARATHION	37 PARATHION
1							
2 MAXIMUM DIST		106			166		
3 MINIMUM		7			20		
4 MEAN		52			88		
5 MEDIAN		49			84		
6 COUNT	0	19	0	0	19	0	0
7 STDEV		28			45		
8							
9							
10							
11 MAXIMUM GRND		119			168		
12 MINIMUM		0			66		
13 MEAN		51			106		
14 MEDIAN		61			99		
15 COUNT	0	13	0	0	13	0	0
16 STDEV		39			26		
17							
18							
19							
20 MAXIMUM SURF		105			148		
21 MINIMUM		10			19		
22 MEAN		49			95		
23 MEDIAN		47			94		
24 COUNT	0	14	0	0	14	0	0
25 STDEV		29			39		

0		38 PHORATE	39 RONNEL	40 2,6-DCP	41 2,5-DCP	42 2,4-DCP	43 3,5-DCP	44 2,3-DCP	45 3,4-DCP
1									
2	MAXIMUM DIST	99		117		140			
3	MINIMUM	20		33		43			
4	MEAN	66		86		101			
5	MEDIAN	68		89		93			
6	COUNT	19	0	16	0	17	0	0	0
7	STDEV	24		20		24			
8									
9									
10									
11	MAXIMUM GRND	108		103		127			
12	MINIMUM	21		47		53			
13	MEAN	57		82		100			
14	MEDIAN	53		92		109			
15	COUNT	13	0	12	0	12	0	0	0
16	STDEV	22		20		24			
17									
18									
19									
20	MAXIMUM SURF	94		90		113			
21	MINIMUM	10		50		47			
22	MEAN	61		71		77			
23	MEDIAN	67		73		69			
24	COUNT	14	0	12	0	12	0	0	0
25	STDEV	23		13		24			

0		46 2,4,6-TCP	47 2,3,6-TCP	48 2,3,5-TCP	49 3,4,5-TCP	50 2,3,5,6 TeCP	51 2,3,4,5 TeCP	52 PCP
1								
2 MAXIMUM	DIST	130		130		133	128	128
3 MINIMUM		33		33		34	34	38
4 MEAN		91		90		91	89	88
5 MEDIAN		93		87		89	89	89
6 COUNT		17	0	17	0	17	17	17
7 STDEV		21		23		22	21	21
8								
9								
10								
11 MAXIMUM	GRND	110		110		117	106	117
12 MINIMUM		43		40		41	39	43
13 MEAN		87		84		84	85	79
14 MEDIAN		90		90		86	89	78
15 COUNT		12	0	12	0	12	12	12
16 STDEV		21		21		21	20	20
17								
18								
19								
20 MAXIMUM	SURF	93		93		100	94	89
21 MINIMUM		37		25		24	22	38
22 MEAN		72		65		61	64	67
23 MEDIAN		75		73		67	67	67
24 COUNT		12	0	12	0	12	12	12
25 STDEV		19		27		24	23	17

0		53 CARBARYL	54 ALDICARB	55 ALD. SULFOX.	56 ALD. SULFONE	57 CARBOFURAN
1						
2	MAXIMUM DIST	125	100	75	115	108
3	MINIMUM	0	73	0	0	0
4	MEAN	70	91	26	76	58
5	MEDIAN	88	97	25	88	62
6	COUNT	8	8	8	8	4
7	STDEV	49	11	22	41	54
8						
9						
10						
11	MAXIMUM GRND	100	100	90	108	100
12	MINIMUM	43	50	25	65	65
13	MEAN	80	81	54	93	82
14	MEDIAN	94	88	58	100	81
15	COUNT	8	4	8	8	4
16	STDEV	25	24	27	16	14
17						
18						
19						
20	MAXIMUM SURF	125	105	28	105	105
21	MINIMUM	25	75	18	75	75
22	MEAN	68	93	24	90	90
23	MEDIAN	50	95	25	88	91
24	COUNT	7	7	7	7	4
25	STDEV	40	10	3	13	16